THURSDAY, JUNE 24, 1886

MR. MINCHIN'S TREATISE ON STATICS

A Treatise on Statics, with Applications to Physics. By G. M. Minchin, M.A. Vol. II. 3rd ed. (pp. 512 + vi.). Clarendon Press Series. (Clarendon Press, Oxon, 1886.)

THIS new edition of this work has been separated into two volumes. The first volume (351 pp.), dealing with "Equilibrium of Coplanar Forces," aims at the standard of Undergraduate Honours; it is noticeable for the frequent use of graphic methods and for a long discussion on funicular polygons (now forming so important a help in graphic applications to engineering); this was published in 1884. The second and longer volume is a masterpiece of constructive skill in the adaptation of modern methods; it is particularly noticeable for the introduction of the theory of screws and of astatic equilibrium, also for an extensive selection of excellent examples, and for the free use of hyperbolic and elliptic functions in solutions: the reading required is thus considerable; it is, in fact, intended for those who seek Honours. The work is so much improved in this edition that it merits an extended notice. The second volume is divided into only seven chapters, each of which is an essay on its special subject. The numbering of chapters and articles is continuous with Vol. I., whilst the pagination is distinct.

Chapter XIII. (the leading chapter, 64 pp.) deals with Non-Coplanar Forces, and contains the usual propositions (16 pp.) about compounding and resolving forces and couples, about resultants, equilibrium, and central axis: then follow (48 pp.) the theory of screws, cylindroids, complexes, and degrees of freedom; the constructions given for the cylindroid are neat: in one the surface is traced by the blades of a pair of scissors, which open horizontally at a uniform rate, whilst the rivet falls vertically; this gives a vivid idea of the surface.

Chapter XIV. (34 pp.) treats of Astatic Equilibrium, which is defined to be a balance amongst forces of fixed magnitudes and directions at definite points of a body subject to displacement. This is treated by quaternions, the Cartesian method being found cumbrous. It is shown that a system of forces can always be astatically balanced by a set of *three* forces in any given directions (and even by three equal rectangular forces) applied at three points lying in a plane fixed in the body, and also by two forces if these points lie in a line, or by one force if they coincide (the general proof of all this is easy by elementary methods). This subject has some practical application in electrical measurements, for which an astatic magnet-pair is much used, and in seismometry, for which it has been sought to make pendulums astatic for small displacements (see Milne's new work on "Earthquakes," p. 26).

Chapter XV. (91 pp.) treats of Virtual Work. The term "work-coefficient" has here been with great advantage introduced to replace the lengthy and *incorrect* term "generalised component of force." Lagrange's method is treated of at length: its advantage is shown to consist in reducing all problems to the case wherein the displacements are independent, by introducing internal forces to represent the constraints. One disadvantage is its undue length, most marked in simple cases. Another is a decided risk of error in estimating the work of the internal forces; instances of error due to this in Lagrange's researches are shown, *e.g.* the cases (1) of an inextensible surface wherein Lagrange assumes (incorrectly) that $\delta dS = 0$ fully expresses the inextensibility; and (2) of an extensible surface wherein he assumes (incorrectly) the work of internal deformation to be simply proportional to dS; and (3) of an elastic wire wherein Lagrange overlooks the distortion. A brief summary of Jellett's researches on inextensible surfaces is given, and it is shown that such a surface is quite determinate (and therefore not deformable) if any bounding edge of it be fixed, except it be anticlastic or developable, which latter admit of deformation when certain edges only on them are fixed. The surface-tensions of liquid-films are investigated (12 pp.), and the experimental way of producing several such forms is given, and their stability discussed.

Chapter XVI. (45 pp.). On Strings and Springs.—The properties of strings in general, also on rough and smooth surfaces, are discussed, with some cases of the extensible string; next those of plane elastic rods and plane springs; lastly, those of a twisted wire (20 pp.): this last is important in electrometers. The interesting *kinetic* analogies are shown (1) of a plane elastic rod with the simple pendulum, and (2) of a bent and twisted uniform wire with a heavy mass moving about a fixed point, viz. that the differential equations in the analogous problems are similar.

Chapter XVII. (123 pp.), on Attraction, is divided into four sections.

Sec. I. (29 pp.). On Attraction in General.—It is explained that the law of gravitation implies that the attracting particles must be very small compared with their distance. Notice is most usefully drawn to this limitation several times in the sequel, *e.g.* it is shown that the Cartesian expressions *seem* to give indeterminate attraction for very close points; also that for attractions more rapid than $1/r^3$ the attraction on an internal point is really infinite.

Sec. II. (40 pp.). On Potential.—In the definition the usual idea of motion from infinite distance has been dropped, and the definition runs as the work done in bringing a tiny mass from a position of zero attraction, &c. (not from infinity): this is much better. The continuity of the gravity-potential and of its first derivatives, the discontinuity of its second derivatives, the absence of maxima or minima thereof in empty space, and the instability of equilibrium under gravitation to several masses are shown. The application of the method of inversion is given; and, amongst many examples, Thomson's solution of the attraction of a spherical shell whose density $\propto$ (distance)^3.

Sec. III. (13 pp.). On Ellipsoids.—After the usual investigation of their attraction, it is shown that the surfaces of prolate and oblate spheroids are not equipotential: various problems interesting in the figure of the earth are given.

Sec. IV. (42 pp.). Spherical Harmonics.—Green's equa-

tion is deduced and its consequences investigated, especially in helping to find potential. Spherical Harmonics occupy the next thirty-two pages. The very convenient and appropriate name "Laplacian" is here assigned to the important "Laplace's coefficients": by analogy the name "Legendrian" might well be applied to Legendre's coefficients; short terms of this kind are useful, and commemorate the inventors. The usual developments are given; the applications to symmetric bodies are interesting, *e.g.* a potential function (*i.e.* one such that $\nabla^2 v = 0$), which is the potential of a symmetric body for all points on its axis, is *the* potential of the body.

Chapter XVIII. (103 pp.), on Small Strains and Stresses, is divided into three sections.

Sec. I. (32 pp.). Small Strains.—This treats of the *small* strains (changes of shape or size) of a body without reference to their causes. It is shown that straight lines, planes, and parallels remain such, whilst spheres become ellipsoids, &c., and there is always one line of no rotation at every point. It is also shown that every strain may be resolved into a pure strain and a rotation, and that the strain proper may be produced by three elongations, or by one elongation and a contraction all round an axis (this is called traction). Torsion is shown to be equivalent to shear, and shear to be equivalent to an extension and contraction, &c.

Sec. II. (22 pp.). Stress.—This treats of internal stress apart from concomitant strain. The usual composition and resolution are investigated, the work of an actual strain and the virtual work of virtual strain are found, and the latter is shown to be an exact differential.

Sec. III. (49 pp.). Stress and Strain.—The relations between the moduli of compression (k) and distortion (μ), the contraction-coefficient (η), and Young's modulus (E) are first traced for isotropic bodies, and the strain- and stress-potentials found for the same, and it is shown that every force-system produces definite strain. The work in pure compression and pure twisting is investigated, and it is shown that twisting couples applied at ends of a cylinder produce pure torsion only in a circular cylinder, so that in other cases the plane sections are deformed. The theory of the slightly bent plane beam is investigated as far as the theorem of three moments. In heterotropic bodies it is shown the conservation of energy reduces the number of independent elasticity-coefficients from thirty-six to twenty-one. St.-Venant's reduction to fifteen for cases where the mutual action of two particles is independent of other particles is discussed, and is shown to lead to the value $\eta = \frac{1}{4}$ for the lateral contraction-coefficient of an isotropic body. Maxwell's researches on the propagation of gravitation are reproduced, and are described as showing that gravitation could be produced by a certain stress over a closed surface propagated through an all-pervading medium (ether) transferring strain like a solid, but further research shows that this ether is not quasi-solid.

Chapter XIX. (45 pp.). Electrostatics.—After the usual elementary propositions it is shown that a "line of force" meeting an electrified conductor obliquely is refracted, and that the charge-distribution over an isolated body is determinate: this leads to interesting problems in soap-bubbles. It is shown from Green's equation that a hollow conductor screens its contents from outer electric disturbance; this has a practical application in protection of delicate instruments inside a metallic cage. Lastly, the theory of electric images is discussed, and examples given.

From the full analysis given it will be seen that the work is a most important one: it is, in fact, one of the best treatises of the day.

ALLAN CUNNINGHAM, Major, R.E.

THE CRUISE OF THE "BACCHANTE"

The Cruise of Her Majesty's Ship "Bacchante," 1879-82. Compiled from the Private Journals, Letters, and Notebooks of Prince Albert Victor and Prince George of Wales, with Additions by John N. Dalton. Two Vols. (London: Macmillan and Co., 1886.)

TO us the chief interest of these two bulky volumes lies in the fact that they are the record of what we may call the technical education of our future King and his brother. It was a right and proper thing for the Prince of Wales to do to see that his sons should become personally acquainted with the leading sections of that great Empire with the conduct of which they will in the future have so much to do. Indeed, in these times, when our colonies are coming so conspicuously to the front, when their affairs are regarded as of Imperial importance, it might be a good thing to insist that our Colonial Secretaries should follow the princes' example, and that no one should be considered qualified for the post of Minister for the Colonies who had not studied their affairs on the spot. Technical education is considered essential nowadays to any one occupying a responsible position in even the humblest of callings; but we fear that statesmanship is still beyond the pale of science.

In the volumes before us Canon Dalton has the lion's share. The princes' contributions have been edited by him from their diaries, note-books, and letters; while he himself contributes long sections in which he brings together much useful information, and discussions on the affairs of the various colonies visited. Of course the writings attributed to the princes are no doubt much indebted to the superintendence of their tutor; at the same time the boyish hands can be traced throughout. The whole work is creditable both to the princes and to Canon Dalton. They certainly worked hard both at their books and at their duties as middies; for in all respects when on board ship they were treated precisely as their mates. They evidently took a genuine interest in their duties on board; took a pride in mastering all the details of navigation and the working of a war-ship like the *Bacchante;* were as eager to pass their examinations as if their future careers depended on the result. Much of their share of the work consists of details as to the day's cruise, their own work as officers, the exercises proper to such a ship, and the incidents of the gun-room. Mixed up with this are the results of their own observations in the countries visited, information gathered during their visits or from books, their experiences when sojourning in the colonies, in Japan and other countries, with occasional reflections suggested by all this. Canon Dalton's contributions are more solid and serious. He enters into

long details on the history and present condition of the colonies, referring at length to the various questions that are uppermost in each, giving as a rule fairly the views of the various parties, though by no means abstaining from showing his own leanings. Certainly the work contains a vast amount of useful statistical, historical, industrial, and commercial information on our colonies, and will be found of service to any one desirous of getting up the subject. Of course it is not to be expected that a work like this will contain much that is novel or of scientific value. In Japan the princes indeed saw a great deal which is not likely to come in the way of the ordinary visitor; while a large portion of the second volume is devoted to Egypt and the Holy Land, which they explored under the guidance of such specialists as Capt. Conder and Sir Charles Wilson, and therefore are able to record much of real and almost unique importance in the geography and antiquities of those interesting countries.

What can Canon Dalton mean by permitting the insertion of the following entry, without note or comment? The apparition is stated to have been seen on the passage from Melbourne to Sydney:—

"July 11.—At 4 a.m. the *Flying Dutchman* crossed our bows. A strange red light as of a phantom ship all aglow, in the midst of which light the masts, spars, and sails of a brig 200 yards distant stood out in strong relief as she came up on the port bow. The look-out man on the forecastle reported her close on the port bow, where also the officer of the watch from the bridge clearly saw her, as did also the quarterdeck midshipman, who was sent forward at once to the forecastle; but on arriving there no vestige nor any sign whatever of any material ship was to be seen either near or right away to the horizon, the night being clear and the sea calm. Thirteen persons altogether saw her, but whether it was *Van Diemen* or the *Flying Dutchman* or who else must remain unknown. [Here are a few German verses on the phantom ship.] The *Tourmaline* and *Cleopatra*, who were sailing on our starboard bow, flashed to ask whether we had seen the strange red light. At 10.44 a.m. the ordinary seaman who had this morning reported the *Flying Dutchman* fell from the foretopmast crosstrees on to the topgallant forecastle and was smashed to atoms. At 4.15 p.m. after quarters we hove to with the headyards aback, and he was buried in the sea. He was a smart royal yardman, and one of the most promising young hands in the ship, and every one feels quite sad at his loss."

Then follows a statement about the admiral having been "struck down," as if it had some connection with the apparition.

The cruise of the princes, which lasted from September 1879 to August 1882, was divided into two well-marked sections. The first, extending to May 1880, included visits to Gibraltar and the Mediterranean, Madeira, the Canaries, West Indies, and Bermudas. After a long visit to Vigo, the second part of the cruise was begun in August 1880. By Ferrol, Madeira, and the Cape Verde Islands the River Plate was made, where some time was spent ashore. After touching at the Falkland Islands, a run was made to the Cape, where several weeks were spent, during which the princes visited several parts of Cape Colony, and showed special interest in the Observatory under Dr. Gill. In the spring of 1881 a long, stormy, and dangerous run was made across the southern Indian Ocean to Cape Leeuwin in West Australia, where the *Bacchante* was compelled to remain some time on account of damage to her rudder. This gave the princes an opportunity of becoming familiar with the peculiar geographical conditions of West Australia, and seeing the actual conditions of colonial life. Then followed long visits to South Australia, Victoria, New South Wales, and Queensland. Some time was spent in the Fiji Islands, of which the princes saw a good deal. Thence a straight run was made for Japan, where the princes had a very busy time indeed in visiting the many sights of that interesting country. Touching at Shanghai, Canton, and the Straits Settlements, the *Bacchante* reached Ceylon, where the princes met Prof. Haeckel, and showed a good deal of interest in him and his work. Then up the Red Sea to Egypt, where and in Palestine three months were spent, months of pretty hard work for the princes. Touching at Greece, Crete, Ceylon, Sicily, and Gibraltar, the *Bacchante* passed out of the Mediterranean and reached home on August 5, 1882, after a cruise during its whole commission of 54,679 miles. There are numerous attractive illustrations in the book, one small map of the world, showing the route, and numerous sectional charts drawn by the princes themselves.

OUR BOOK SHELF

Dogs in Health and Disease, as Typified by the Greyhound. By J. S. Hurndall. Pp. vii. + 81. (London: E. Gould and Son, 1886.)

Dogs: their Management and Treatment in Disease. By G. Ashmont. Pp. v. + 212. (London: Sampson Low, 1885.)

THE first of these two manuals is intended to assist owners of dogs in diagnosing the complaint from which the animal is suffering, and to suggest remedies which may be applied until professional advice can be secured. The book advocates the "homœopathic" system of treatment, and the first twenty-five pages are devoted to a general exposition of this system "in simple unconventional language."

The second book is much fuller in detail, and is evidently suitable as a hand-book for the veterinarian; the mode of treatment differs very considerably from that recommended in Mr. Hurndall's manual, but we must leave to those practically acquainted with the subject the decision as to the relative merits of the two systems. The section relating to hydrophobia is naturally of interest at present; this disease is more fully treated than any other, though the author points out its extreme rarity; nevertheless it is admitted that the danger to persons bitten by a really mad dog is considerable—one-third to four-fifths of the cases, according to whether the wound has or has not been cauterised, are said to be fatal. On the other hand, Mr. Hurndall (p. 52) quotes eighty cases of persons bitten by mad animals, of which not a single one terminated fatally.

The section relating to parasites is somewhat meagre, though the author may be right in saying that the study of these animals more nearly concerns the zoologist than the veterinarian. These principles are perhaps carried a little too far when *Ascaris marginata* is spoken of as a "lumbricoid" which "resembles the common earthworm." The book is carefully written, and free from obvious misprints, but the large amount of matter compressed into a small volume has rendered necessary the use of rather inconveniently small type. F. E. B.

Our Island-Continent: a Naturalist's Holiday in Australia. By Dr. J. E. Taylor, F.L.S. With Map. (London: S.P.C.K., 1886.)

DR. TAYLOR took a trip to Australia for his health, during which he visited South Australia, Victoria, and New South Wales. He has of course scarcely anything new to tell us, though his little book is pleasant reading, and many features of the island-continent are brought out that would only strike a naturalist. Why does Dr. Taylor not state the year of his visit?

The Handy Guide to Norway. By Thomas B. Willson, M.A. (London: Stanford, 1886.)

THIS is a business-like and compact guide which can easily be put into the tourist's pocket, though its price is rather surprising. This is probably due to the fact that it contains many sectional maps, an exceedingly useful feature to the intelligent traveller. The appendix on the Flora and Lepidoptera of Norway, by Dr. R. C. R. Jordan, will prove serviceable to the tourist interested in natural history.

Mountain Ascents in Westmoreland and Cumberland. By John Barrow, F.R.S. (London: Sampson Low and Co., 1886.)

MR. Barrow is an experienced Alpinist, but has a genuine appreciation of the gentler heights of his native land. He has ascended nearly every peak of any consequence in the Lake region, and this volume describes simply and clearly how he did it. The book will be useful as a guide to any who wish to follow Mr. Barrow's example; while the notes on the botany of the district render it of some scientific interest.

An Account of a West Indian Sanatorium, and a Guide to Barbados. By the Rev. J. H. Sutton Moxly. (London: Sampson Low and Co., 1886.)

THIS is a special plea for Barbados as a health resort, and Mr. Moxly adduces many facts in support of his position. The climate is superb, and the great drawback is want of drainage, giving rise to epidemics of typhoid fever. The book is well worth perusal by those in search of a winter-summer. The book will be useful as a guide, though we regret to note the absence of any map.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Fishermen's Foul Water

PERMIT me to call attention to the fact that the small gelatinous masses that annually, about this time, cause the sea-water to become what fishermen call "foul," are now in great abundance on this coast. Their recurrence this year being somewhat later than usual is doubtless owing to the low temperature of May.

On viewing a sample of the water in a glass vessel, the spherical and pyriform masses giving a brownish tinge are readily seen; and a pocket lens makes evident the presence of large specimens of the diatom *Eucampia britannica* that are seen as perfect spirals, some of which have four or five complete turns, and also some filamentous rods. Microscopic examination of the sediment deposited in the course of a few hours enables one to see *Rhizosolenia*, *Asterionella*, and several other diatoms whose names are not known to me.

Respecting the gelatinous bodies, I may remark that they are studded with granules that appear to be nucleated.

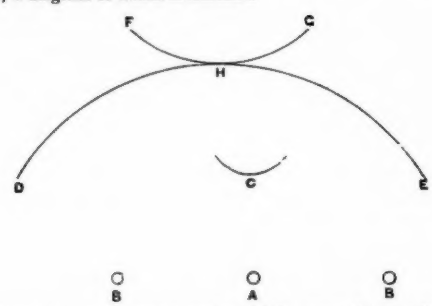
In one of these masses that I have had under observation to-day there has been a gradual segregation of the embedded germs, and this evening these exhibit individual movements which I think indicate the existence of cilia, although with a ¼-inch objective and C eye-piece (the highest power at hand) I cannot distinguish the cilia themselves.

It will be interesting to know how far round our shores at the present time these organisms extend, and I hope, by thus again directing attention to them, that some one more competent than myself will be led to investigate their life-history.

Sheerness W. H. SHRUBSOLE

Solar Halo

AT 6 p.m. this evening I observed an unusual halo and mock suns, a diagram of which is annexed.



A, the sun; B, B, mock suns; C, portion of halo, convex side towards sun; D E, portion of halo, concave side towards sun; F G, portion of halo touching D E at H. Distance—A to B, 22°; A to C, 22°; A to H, 44°.

The sky after having been overcast for the largest portion of the day was at this time fairly clear; very little lower cloud, but a good deal of cirrus. The measurements were observed with a sextant, and were exactly as given, reading the even degree in both cases. T. H. TIZARD

H.M.S. *Triton*, Great Yarmouth, June 21

Ampère's Rule

IN reviewing Mr. L. Cumming's "Electricity Treated Experimentally," "J. T. B." (NATURE, May 27, p. 74) humorously points out how easily students may get confused in trying to make use of "Ampère's rule." There is another rule, published by Pfaundler if I am not mistaken, which is in so far much simpler, as it does not compel the imagination to fancy movements and actions of the human body which it in reality never could perform:—

"Follow the direction of the current in moving the ***right*** hand along the wire, but holding it so that the stretched fingers are parallel to the wire and the palm is turned towards the north pole of the magnet. The outstretched thumb then gives the direction in which the north pole will be deflected."

Dresden-Striesen, June 12 G. DAEHNE

THE A.O.U. CODE AND CHECK-LIST OF AMERICAN BIRDS

SOME few years since the British Ornithologists' Union appointed a Committee to draw up and publish an authoritative list of the birds of the British Islands. This Committee consisted of the following English ornithologists:—P. L. Sclater (Chairman), Osbert Salvin, F. Du Cane Godman, Henry Seebohm, Howard Saunders, H. E. Dresser, R. Bowdler Sharpe, and H. T. Wharton (Secretary). The Committee held seventy-one meetings, and ultimately a list of British birds was published under the title "A List of British Birds, compiled by a Committee of the British Ornithologists' Union."

Notwithstanding the adverse criticism which has been passed on this little book by a few ornithologists, there can be no doubt that it has supplied a want, and that the high scientific position of many of the members of the Committee invested the publication with a degree of

authority worthy of the object of the work in question. Undoubtedly the "List" will bear improvement, and the second edition will perhaps contain not a few modifications, the constitution of the original Committee having necessarily embraced men holding different opinions on the subject of nomenclature and classification. Still, taking the results of their labours as a whole, it seems to us that the work was as well done as could have been expected, and was a well-meant attempt to introduce uniformity into the nomenclature of British birds.

But since the publication of the B.O.U. "List" a complication has arisen through the action of Mr. Henry Seebohm, whose work on British ornithology we have more than once alluded to in this journal. Mr. Seebohm makes short work of nomenclatural difficulties as far as British birds are concerned. Where any doubt arises respecting the oldest published name of a bird, or in cases when obscurity surrounds the meaning of an ancient description, Mr. Seebohm cuts the Gordian knot by taking the general consensus of opinion amongst ornithologists of repute, *i.e.* "*auctorum plurimorum*," and where he finds an actual majority of them have adopted a certain name, then he considers the latter to be the best known, and uses it accordingly. There is a decided advantage about this method. It simplifies matters amazingly, because in such cases as those of the Chiff-chaff, Garden-warbler, and many other familiar birds, the best-known names, *Phylloscopus rufus* and *Sylvia hortensis*, are restored to them, instead of *P. collybita* and *S. salicaria*, which Prof. Newton had shown them to be with more strictness entitled to. It is probable that had a few more years elapsed before Mr. Seebohm published his work, he would have had to modify his nomenclature even while adopting his *auctorum plurimorum* principle. For this reason. There is no ornithologist in this country more looked up to and respected than Prof. Newton, and with good cause. All his work is of the very best, and when he publishes anything, every ornithologist, whether approving his conclusions or not, knows that they are the result of the most careful and deliberate work, on which no time or labour has been spared, and be it an encyclopædia article or a complete work, the student may be sure that he will find the subject worked up in a way that will leave little for him to add. This is our experience of Prof. Newton's work, and it is work which will stand the test of time, for, as long as ornithology is studied, Prof. Newton's publications will always be found to carry the history of his subject down to the time in which he wrote, forming a starting-point for future study. Such being the position of the editor of the fourth edition of Yarrell's "British Birds," it is not surprising to find that his new edition of this standard work was received by ornithologists with respect, and that his nomenclature was at once adopted by the majority of the younger students in this country. Mr. Seebohm's synonymy of British birds shows this over and over again. Then the influence of Mr. Dresser's "Birds of Europe" cannot be under-rated, for he is content to sit at the feet of Prof. Newton, and unhesitatingly adopts his conclusions. Nor could he have done better, for the original work in the "Birds of Europe" is of the poorest quality, and it is as a successful and indefatigable compiler that Mr. Dresser is recognised, viewed in which light there can be no doubt that his work will be considered the work of reference on European ornithology for a long time to come. Thus we have the nomenclature of Prof. Newton, by its adoption in Mr. Dresser's standard work, doubly enforced on the ornithologists of Great Britain, and so followed by them that, as his synonymy shows, Mr. Seebohm would have found that in a few more years it would have been *auctorum plurimorum*, according to his own principles of nomenclature. Prof. Newton adheres faithfully to the rules of the British Association, and one knows, therefore, the principles by which he is guided. Mr. Seebohm differs on many questions from the Association Code, and we have our own ideas as to certain points of nomenclature, our protest being chiefly against men of the Bonapartian school, who take Linnean specific names and make them generic, adding a new specific name of their own. To our mind, Linnean names should be held sacred by zoologists, even if it involves the adoption of the subsequent genus, so that we must admit *Pica pica* or *Crex crex*. The question has been argued over before, and the usual verdict is against the adoption of this mode of nomenclature; but we have not found it unworkable in practice, and indeed it is often convenient, marking out the typical species of the genus. Sufficient has been said in the foregoing remarks to show that there is considerable variability of opinion even amongst British ornithologists with regard to the adaptability ot the Association Code to the requirements of modern science.

But, between the method in vogue in England and that employed by American ornithologists, there has long been great divergence, increasing with years. We have all been looking for some authoritative, *and final*, work on the birds of North America, and it is with pleasure that we have lately received the "A.O.U. Code and Check-List of North American Birds," published by the American Ornithologists' Union. The Committee appointed for the purpose of drawing up this "List" was an excellent one, consisting of Prof. Elliott Coues, Messrs. J. A. Allen, R. Ridgway, W. Brewster, and H. W. Henshaw, while they also received the co-operation of Dr. L. Stejneger, who has made some notable researches into the synonymy of birds during recent years.

The "A.O.U. List of North American Birds" forms a bulky volume of nearly 400 pages. It is divided into five parts: an Introduction (pp. 1–17), in which a history of the subject is given, showing the various efforts of Committees and individual naturalists to systematise the treatment of scientific nomenclature. This is very completely done by the A.O.U. Committee, and with admirable fairness to the labours of their predecessors. Then comes the second section, propounding the "Principles, Canons, and Recommendations" (pp. 18-69), the "Check-List of North American Birds," according to the canons of nomenclature of the American Ornithologists' Union (pp. 71–347),[1] a "Hypothetical List" of recorded North American birds whose status is doubtful (pp. 349-357),[1] and, lastly, a most useful list of the "Fossil Birds of North America" (pp. 359-367).

The introduction calls for no remarks, but it is the "Principles and Canons" of the A.O.U. which will interest the British ornithologist.

In looking through the check-list and comparing the nomenclature used for some of the Palæarctic and Nearctic birds, the ordinary student will be somewhat startled. *Colymbus* is no longer to be retained for the Divers, but for the Grebes, and the Divers become *Urinator*, so that our ordinary Red-throated Diver, familiar as *Colymbus septentrionalis* is now *Urinator lumme*, of the American "List." From this it will be seen that the latter does not simplify existing nomenclature to begin with, and it is the great love of change, which has been so characteristic of recent ornithological work in America, which makes us sceptical as to whether even the authority of the A.O.U. "List" will be sufficient to prevent further modifications in this direction. We remember well how in our younger days we fell into the nomenclatural snare, and how we carried out, as we thought wisely, changes of well-known names in favour of one which had priority of a few years; and in one instance we remember rejecting a well-known name for another because the latter occurred a few pages earlier in the same book. These errors of judgment we have lived to repent, because we find with increasing experience that

[1] By some mistake the pages in the Table of Contents referring to these two sections are not correctly given (p. viii.).

the study of ornithology presents many phenomena of far deeper interest than the mere search after the oldest name, resulting, as it does too often, in the unearthing of some utterly unknown title, to the confusion of the student. The same principles of nomenclature which we tried to follow in earlier days are those of the A.O.U. now, which result in *Urinator lumme* as the name of the Red-throated Diver. And it is not as if there will be any finality about this nomenclature, for we have seen the treatment of too many monographs to make us believe this. When an ornithologist takes up a group of birds and monographs it, he spends months or even years of study on this particular group, obtains a grasp of his subject, and does his level best to give finality to his work. Does he succeed? Seldom, if ever. We hold it as an absolute canon that the nomenclature of monographs should be followed, unless a definite reason is given why a name should be altered. But, instead of this being done, we find, over and over again, that the author of a small paper or of a faunal list will, by altering generic names and so re-shuffling the specific names, give a totally different aspect to birds which have only just before been carefully monographed with a hope of finality in their nomenclature. So will it probably be with the A.O.U. "List," when some ornithologist in America will rise up and (as we expect to see before long) declare the trinomial system unworkable or the nomenclature of the "List" too complicated, and will re-shuffle the names, and attain temporary renown.

We think, however, that, now that the two leading Ornithological Societies of England and America have spoken with authority on the subject of the nomenclature of the birds of their respective countries, the British Ornithologists' Union should endeavour, if possible, to confer with the sister Society in America, and see if a common ground of agreement cannot be arrived at. If these two bodies came to a settlement, the whole matter could be laid before an Ornithological Congress, and there would be some hope of unanimity for the future. The points of divergence in practice between English and American ornithologists are less than might be supposed. The two principal ones are the adoption by the A.O.U. of the 10th edition of Linnæus's "Systema Naturæ" instead of the 12th edition, and the employment of trinomial nomenclature. So many English ornithologists are now using the latter mode that there ought to be no difficulty in conceding the latter point if any ornithologist like the method. Formulated as it is in the A.O.U. "Code," there is no difficulty in understanding what is meant by the trinomial titles, and the American Committee have given a clear definition of their object in Canon XI., though the difficulties which have been pointed out on this side of the water are still not disposed of. "In a word, intergradation is the touchstone of trinomialism. It is also obvious that, the larger the series of specimens handled, the more likely is intergradation between forms supposed to be distinct to be established, if it exists." So says the canon above quoted; but, we would ask, if two forms absolutely intergrade, why are they not of the same species? and why will not a binomial title be sufficient? and again, what name is to be given to the specimens collected at the point of contact? Or again, if a larger series of specimens proves that two species do not intergrade, as they were at first supposed to do, then they will each once more bear a separate specific name. Further, are trinomials to be used for insular forms, as is done by Mr. Allen for *Loxigilla noctis sclateri* from Santa Lucia, as there is no chance of intergradation between it and *L. noctis* from the neighbouring islands? Trinomial nomenclature has, however, taken such a place in American ornithology, and is adopted by so many naturalists in the Old World, that the principle must be conceded to all who like to avail themselves of it. The question with regard to the tenth edition of Linnæus's "Systema" might also be got over, but the A.O.U. will have greater difficulty in convincing European naturalists that it is advantageous to the progress of ornithological science to alter established nomenclature by introducing *Chelidon* as the generic name for the Chimney-swallow instead of the feather-legged Martins, which are to be henceforth *Hirundo*. This radical change is to be adopted in homage to Forster's "List of British Birds," a mere list of names without a character for a single genus. Although similar lists have sometimes been accepted for specific names, their recognition in the case of genera is rare, although in many instances long-established usage has rendered some of them familiar.

The few objections which we have made above must not be supposed to lessen our respect for the general tenour of the work now issued by our American *confrères*, whose labours deserve our most careful consideration, while it cannot be doubted that the publication of this "Code and Check-List" will have great influence on the future of zoological nomenclature.

R. BOWDLER SHARPE

PROFESSOR NEWCOMB'S DETERMINATION OF THE VELOCITY OF LIGHT[1]

THE method selected for the important experiments described in the present memoir,[2] is that known as Foucault's. The idea fundamental to it is that of the determination of the interval occupied by light in flashing from a revolving to a fixed mirror and back, by the amount of deviation produced in its return path through the change meantime effected in the position of the revolving mirror. The angle of deviation of the ray is double the angle of displacement of the reflector; to this angle corresponds (since the mirror rotates at a known rate) a definite fraction of a second, which is the time of luminous transmission across twice the measured distance between the mirrors.

But this theoretically simple means of ascertaining the velocity of light is complicated, in practice, with innumerable difficulties. A choice demanding the utmost nicety of judgment must be made between various conflicting conditions; sacrifice in one direction is the price of advantage in another; a balance has to be struck, giving the largest sum-total of facilities, with the fewest and least intractable drawbacks. The plan finally decided upon by Prof. Newcomb was the result of much anxious deliberation: we hope to render it, in its main outlines, intelligible to our readers.

A fundamental condition of the problem is to get an image of the light-source absolutely coincident with the light-source itself, *so long as the movable mirror is at rest*. And this, whatever be the position the mirror is at rest in, provided only that it be such as to permit the rays sent out by it to return, after due triple reflection, to the eye. This requisite is secured by locating the centre of curvature of the distant concave mirror in the axis of the revolving plane one. All rays emitted from this point towards the former will return along the same paths; differences of direction due to differing positions of the movable mirror will be eliminated by the return reflection; and there ensues a "stationary image" of the light-source, occupying, when visible at all, an invariable situation.

So far, all the operators by Foucault's method have been unanimous; but in the placing of the lens indispensable for the management and concentration of the light employed, a material distinction obtained between the

[1] "Measures of the Velocity of Light made under direction of the Secretary of the Navy during the years 1880–82," by Simon Newcomb, Professor, U.S. Navy. Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac, vol. ii. parts iii. and iv. (Washington: Bureau of Navigation, 1885.)

[2] For the historical notice serving as an introduction to it, see NATURE, May 13, p. 29.

plan of experiment chosen by Prof. Newcomb, and that pursued by Prof. Michelson in his similar investigation at the Naval Academy in 1879 (see NATURE, vol. xxi. pp. 94, 120). Fig. 1 represents in principle the arrangement adopted by the former, which was also that used by Foucault. In it the lens, L, is placed between the light-source, S, and the revolving mirror, A. Fig. 2 shows the disposition preferred by Michelson, in which the lens is interposed between the revolving and fixed mirrors. In both equally, S and M are, and for the purpose in view necessarily must be, in conjugate foci of the lens.

A disadvantage of the first form is that the measurement of any considerable deviations will be attended by uncertainties caused by the oblique passage through the lens of the return beams. It was, however, obviated in the experiments under consideration, by the use of *two* lenses—one for the outgoing, the other for the incoming rays. The second method (Michelson's) promises increased brilliancy of the image; which may, nevertheless, be regarded as outweighed by atmospheric and other impediments to its distinctness, as well as by the illumination of the field of view produced by the passage through it of some part of the lens with every revolution of the mirror. The method exemplified in Fig. 1 was then chosen by Prof. Newcomb as affording more or less calculable conditions; while No. 2 involved all the uncertainties of definition habitually besetting astronomical observations.

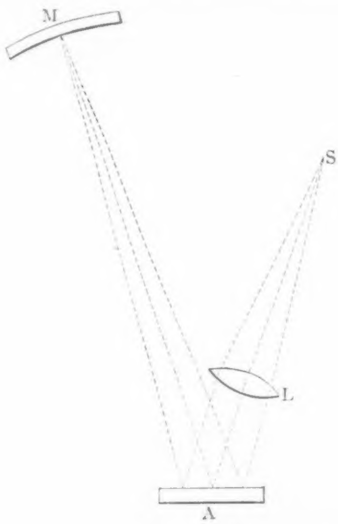


Fig. 1.

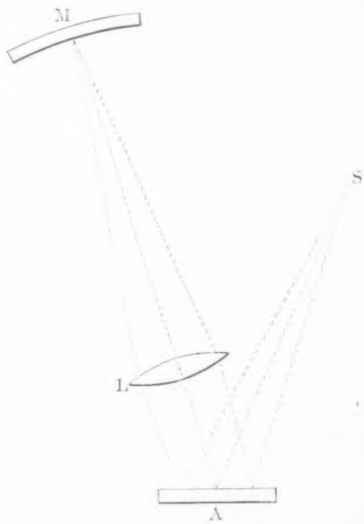


Fig. 2.

Let us now endeavour to realise the nature of the experimenter's immediate task. The precise measurement of an angle actually constitutes it. From the mirror A, so long as it remains at rest, an image is reflected in a certain direction; but no sooner is A set rapidly rotating, than the same image is reflected in a slightly different direction. The amount of this difference—in other words, the angle of deviation—is the object to be ascertained.

Obviously, the first desideratum is to render the inevitable error of measurement comparatively small, by making the quantity to be measured large. Two roads are open towards this end. A high velocity can be given to the mirror A; or a great distance can be interposed between A and M. By the first means, the angle rotated through in a given time will be augmented; by the second, the time available for the displacement of the reflector will be prolonged by the lengthening of the journey imposed upon the rays to be reflected. The difficulties hampering increased speed are purely mechanical, though none the less formidable; those in the way of a lengthened path are optical.

The preservation of light enough to keep the image bright and distinct is of paramount necessity for the avoidance of ruinous uncertainties in its measurement. Now, in Foucault's experiments, the object affording the image was the line of a reticule. It was dark upon a bright ground; a platinum-wire relieved against a sheaf of sunbeams. But no perfectly defined image of such an object could be formed at any considerable distance; and we find, accordingly, that the utmost length by which he ventured to separate his mirrors was twenty metres. His entire apparatus was, in fact, contained in a single room. Hence, notwithstanding a speed given to his mirror of from 600 to 800 revolutions per second, the actual linear deflection of the return ray amounted to no more than seven-tenths of a millimetre. Chiefly by employing as his light-source an illuminated slit, the lucent image of which on a dark ground bore the enormous loss of light ensuing from the transportation of the fixed mirror to a distance of close upon 2000 metres, Michelson was enabled to augment this deflection some two-hundred-fold. The resulting velocity for light of 299,910 kilometres per second was proportionately trustworthy, the error of the angular measurement upon which it immediately depended being estimated to be one hundred times less than in Foucault's determination. Prof. Newcomb's improvements carried him still further towards absolute accuracy.

The details of construction of his "phototachometer" were decided on in the summer of 1879, and the instrument was completed by the Messrs. Clark in May 1880. It consisted essentially of four parts—a sending and a receiving telescope, a revolving and a fixed mirror. Sunlight, thrown from a heliostat through an adjustable vertical slit at the eye-end of the sender, passed down the tube, which was bent at right-angles to get it out of the way of the observing telescope, and after reflection by a plane mirror at the elbow, passed out through the objective towards the revolving mirror. This was formed by a

rectangular prism of polished steel, 85 millimetres in height, and with a cross-section of 37·5 square millimetres. The vertical faces constituting the reflecting area were nickel-plated, and proved of a remarkably durable though not very high polish. Motion in opposite directions at will was communicated by two air-turbines, acting one at the top, the other at the bottom of the mirror, and serving, by a simple contrivance, each for the regulation of the contrary velocity imparted by the other. A wheel-work arrangement, by which an electric current was broken once for every twenty-eight revolutions of the mirror, gave the means of obtaining a chronographic record of its rate of going. Two fixed mirrors, mounted side by side on cast-iron stands, were employed to return the light sent to them by the revolving mirror. Each was about 40 centimetres in diameter, and had a radius of curvature of some 3000 metres. The object-glass of the receiving telescope was (in the first instance) placed immediately under that of the sender, the former thus directly facing the lower, the latter the upper section of the movable mirror. The two *tubes*, however, owing to the "broken" form given, as already mentioned, to that of the sender, made with each other an angle of 90°. Horizontal movement round a vertical axis coincident with that of the rotating mirror, was possessed by the observing telescope, to which was attached a pair of microscopes for reading off the divisions on a horizontal divided arc fixed to a stiff frame at its further end. The amount of this horizontal motion of the telescope measured the deviation of the thrice-reflected sunbeam, and, by an immediate deduction, its velocity.

The site chosen for the erection of the apparatus was Fort Myer, on the south side of the Potomac, overlooking the city of Washington. The stationary mirrors, to and from which the carefully guarded rays performed their trips, were placed, to begin with, in the grounds of the Naval Observatory, at a distance of 2551 metres from Fort Myer; but were in 1881 removed to a point at the base of the Washington Monument, at a distance increased to 3721 metres. Some tentative experiments were undertaken on June 22, 1880; after a few days' trial, however, it was found that the wheel-work for counting the revolutions of the mirror was destroyed by the rapidity of the impressed movements. New wheels wore out almost before a set of readings could be obtained with them; until at length the Messrs. Clark, finding that no metal would stand the inflicted wear and tear, substituted *raw hide* as the material for the first wheel, a device which proved wholly successful. With the instrument thus modified work was begun on August 9, and continued without interruption until September 20. The transportation of the fixed mirrors to the Monument station in the spring of 1881 postponed the commencement of operations to August 8; and their effective prosecution was then impeded by the discovery of a source of systematic error in a "torsional vibration" of the rotating mirror. That is to say, the steel prism employed to reflect the light, no longer, when its speed attained a certain point, revolved as an absolutely rigid whole, but *tended towards* the possession of different velocities in its different parts. Hence a slight twisting of its mass producing vibrations round the axis of rotation, the effect of which was visible in the breaking up of the image of the slit into four separate images, one due to each of the faces of the prism. The persistence of this baffling symptom compelled a modification of the instrument, by which the sending and receiving telescopes could be respectively depressed and raised so as to alternate their positions, and the portions of the mirror they were directed towards. The mean of any two complete sets of observations made with the telescopes thus interchanged would be free, as Prof. Newcomb shows, from the effects of any probable form of torsional vibration.

No such effects, however, were apparent in the observations of 1882. This last series extended from July 24 to September 5, and were so nearly free from accidental differences that the probable error of a complete determination was scarcely more, under good conditions, than the ten-thousandth part of the whole. Upon these, accordingly, the chief reliance was placed in the final discussion of results.

The announcement that Messrs. Forbes and Young had detected a difference of 2 per cent. in the rates of transmission of red and blue light prompted, at Fort Myer, a most careful watch for traces of colour in the reflected image of the slit. But although, from a discrepancy of even one-twentieth that amount, a spectrum 15″ in breadth must have ensued, the iridescent edges which would infallibly have betrayed its presence were not seen.

An important novelty in Prof. Newcomb's method was his use of opposite rotations and their accompanying opposite deviations. In his instrument the mirror, as already stated, could be made to revolve at pleasure, either from right to left or from left to right. Instead, then, of measuring, as had always previously been done, the deflection produced in the return ray by the change from rest to an ascertained rate of rotation, the object of his determinations was the total deflection due to extremes

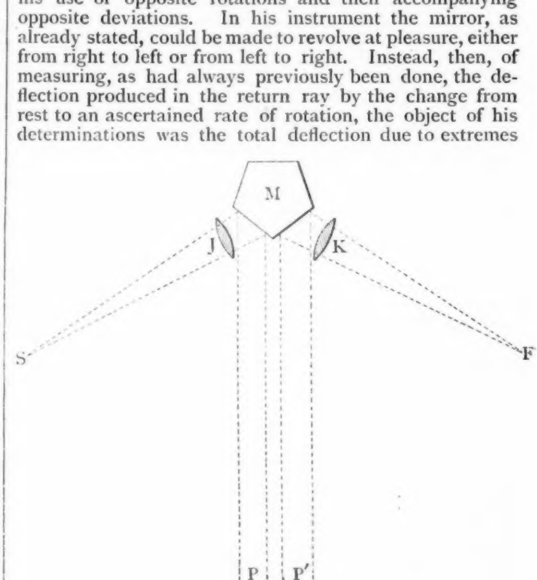


Fig. 3.

of contrary movement. The mode of experimenting was briefly as follows.

First, the valve was opened to the air-blast giving *negative* rotation, the receiving telescope being set upon some division near one extremity of its arc; the image of the slit was then accurately fixed, by the regulating agency upon the velocity of the mirror of the opposing air-current, upon the middle wire of the micrometer; the chronograph made its record of the rate of going, and the microscopes were read. This constituted what was called a "run," and occupied two minutes or upwards. The telescope was next unclamped, and directed near the opposite end of the divided arc. *Positive* motion was given by opening the other valve, and the process of fixing the image and reading off repeated. A comparison of the two sets sufficed to determine the time spent by the light in passing to and from the mirrors on the other shore of the Potomac.

This method of contrary deviations is most strongly recommended by Prof. Newcomb to future investigators. It combines the two advantages of doubling the angle to be measured, and of abolishing possible errors in the determination of the zero-point. In the present series, velocities, alternately in opposite directions, rarely ex-

ceeding 230 revolutions per second,[1] gave a total change of direction of nearly 8°. And this largeness of the measured angle materially contributed to enhance the accuracy of the results. Highly effective, also, for the same end were the elaborate precautions for darkening the telescopic field of view, and thus rendering the image of the illuminated slit more distinct. As their upshot, daylight was reduced to about one-thousandth its normal intensity. What was left only just sufficed to show the spider-lines without artificial light. The necessity for such precautions may be estimated from our author's statement that a concave mirror, of which the diameter should be one decimetre for each kilometre of distance, would receive only 1/60,000 part of the light reflected from the revolving mirror; while of that 60,000th part only a small fraction could be practically turned to account, owing to the many sources of loss in reflection and transmission. Since, however, *two* fixed mirrors, each four decimetres across, placed at a distance of less than four kilometres, were employed in the operations at Fort Myer, the proportion of light there returned was rather more than double the above estimate. Prof. Newcomb appears to have been, on the whole, eminently successful in his optical arrangements. The imperfect definition which was the besetting difficulty of Michelson's experiments gave him little trouble.

The recent American determinations of the velocity of light, justly considered as of far superior precision to any others yet executed, give the following results:—

Michelson, at Naval Academy, in 1879	299,910 km.
Michelson, at Cleveland, 1882	299,853 „
Newcomb, at Washington, 1882, using only results supposed to be nearly free from constant errors	299,860 „
Newcomb, including all determinations	299,810 „

To these are added for comparison:—

Foucault, at Paris, in 1862	298,000 „
Cornu, at Paris, in 1874	298,500 „
Cornu, at Paris, in 1878	300,400 „
The same, discussed by Listing	299,990 „
Young and Forbes, 1880-81	301,382 „

Prof. Newcomb's finally-concluded result is that light travels *in vacuo* at the rate of 299,860 ± 30 kilometres per second. And the probable error of thirty kilometres, small as it is, has been liberally estimated. A determination so satisfactory of this important element goes far towards solving the problem of the sun's distance. Combined with Nyrén's constant of aberration, 20″·492, it gives, for the solar parallax, the value of 8″·794. The corresponding distance of 149·61 million kilometres, or 92,965,020 miles, agrees quite closely with Dr. Gill's result from the opposition of Mars in 1877, and exceeds by only 165,020 miles the mean deduced by Mr. D. P. Todd from earlier determinations of light-velocity. No information as to the dimensions of the solar system which we are ever likely to get from a transit of Venus can approach in reliability the present conclusion.

Prof. Newcomb is so far from believing that the *ne plus ultra* of accuracy has been reached in his own remarkable experiments, that he appends to the detailed description of their method some valuable suggestions for its improvement. He had hoped, indeed, he tells us, to reach a concluded value exact to between five and ten kilometres, which, after repeated verification, might be available as a test of the invariability of standards of length. The further prosecution of the inquiry, however, he now leaves to any physicist who may be invited to the task by the promise of his advice and co-operation.

Fundamentally, he holds that the system pursued at Fort Myer in 1880-82 is preferable to any other yet tried. No known expedient for ascertaining the rate of transmission of light is comparable to that of its deflection, after a measured journey, by a moving mirror. The apparatus by which this plan was realised admits, however, in his opinion, of some amelioration in detail. The disadvantageous necessity, for instance, of appropriating a separate section of the reflecting surface to the outward- and homeward-bound rays could be removed by the substitution of a pentagonal for a quadrangular prism, as shown in Fig. 3, where M is a section of the revolving mirror, J the object-glass of the sender, receiving light from the slit S, and throwing it in the direction P towards the distant reflector. On its return along the path P′, the ray is reflected from an adjoining face of the revolving mirror into the receiving telescope, K.

The closing words of the paper under review attest the unappeased aspiration towards accuracy characteristic of the successful investigator.

"A still further perfection of the method," its author writes, "which would lead to a result of which the precision would be limited only by our means of linear measurement is, I conceive, within the power of art. It consists in placing the fixed mirror at so great a distance that the pentagonal revolving mirror would move through an arc of nearly 36° while the ray is going and returning. If a speed of 500 turns per second could be attained, the required distance would be thirty kilometres. Then, in opposite directions of rotation, the return ray would be reflected at phases of the mirror differing by the angle between two consecutive faces. The result would be that the receiving telescope would need to have but a small motion, and all the observer would have to measure would be the small angle by which the difference of positions of the mirror when the flash was received in opposite directions of rotation, differed from 72°. In the Rocky Mountains or the Sierra Nevada no difficulty would be found in finding stations at which a return ray could be received from a distance of thirty, forty, or even fifty kilometres, with little more dispersion and loss than at a distance of four kilometres through the air of less favoured regions. It is true that the surface of the distant reflector would have to be increased in proportion to the distance, but it would not be necessary to make a single reflector of great size. A row of ten reflectors, each six or eight decimetres in diameter, might be sufficient to insure the visibility of the return ray."

A. M. CLERKE

[1] Michelson's revolving mirror executed 256 turns in a second.

NOTES

AT a meeting of the Royal Society of Edinburgh on June 7, medals were presented as follows:—To Mr. John Aitken (Darroch), the Keith Prize for 1883-85, for his paper on the formation of small clear spaces in dusty air, and for previous papers on atmospheric phenomena; to Edward Sang, LL.D., the Makdougall-Brisbane Prize for 1882-84, for his communication on the need for decimal subdivisions in astronomy and navigation and on tables requisite therefor, and generally for his recalculation of logarithms both of numbers and of trigonometrical ratios; to Mr. B. N. Peach the Neill Prize for 1883-86, for his contributions to the geology and palæontology o Scotland.

THE organising committee of Section A has arranged that a special discussion shall be held, at the Birmingham meeting of the British Association, jointly with Section D, on the physical and physiological theories of colour-vision. The discussion will be opened by Lord Rayleigh, and Dr. Michael Foster will also take part in it. Persons who wish to contribute papers bearing on the subject of discussion are requested to send their names to the Recorders of Sections A or D, at 22, Albemarle Street, W., not later than August 1.

THE death is announced, in his seventieth year, of Mr. Llewellyn Jowett, the well-known archæologist.

AT the Conference at the Colonial and Indian Exhibition on Wednesday, June 23, a paper was read by Mr. W. Lant Carpenter, on "The Position of Science in Colonial Education." The colonies to which Mr. Carpenter had directed his attention were:—Canada generally; South Africa, the Cape of Good Hope and Natal; Western and South Australia, Victoria, New South Wales, Queensland, New Zealand, and Tasmania, the last of which, unfortunately, is not represented at the present Exhibition. An account of the present condition of scientific education in each of these colonies was given. As a general conclusion, Mr. Carpenter thought that the claims of science to a place in State-aided primary education were more fully recognised than in the old country, and this, not merely because it was the only foundation upon which a system of technological education could be securely built, but for its value in drawing out the minds of the pupils. As regards the branches by which the time-honoured routine of subjects may be most beneficially varied, precedence was almost universally accorded to drawing, and to the objective presentation of the elements of science. In secondary grammar and high schools, however, science scarcely occupied a position equal to that in corresponding English schools, but there were many signs of improvement in this respect. In the Colleges and Universities of the older colonies the classical and academic influence was still very strong, while in the newer ones the claims of scientific education to be put on an equal footing with literary were recognised. Great has had been the progress of public opinion in England during the last few years on the importance of science as an element in education, the author was disposed to consider it greater in the colonies in the same period. Certainly the development of that opinion to its present point had been much more rapid in the colonies than at home. There were many voluntary colonial Associations for the promotion of science, and the author concluded his paper by throwing out the suggestion that, if there were grave and practical difficulties in the way of an Imperial federation of the Australian colonies, the establishment of an Australian Association for the Advancement of Science, somewhat on the lines of the British and American Associations for similar purposes, might not be beyond the reach of practical men of science, and he was strongly of opinion that such a federation would tend to strengthen "the position of science in colonial education."

ARRANGEMENTS have been made for the examination in the Indian Court of the Colonial and Indian Exhibition of certain commercial products, which are believed to be insufficiently known or to be suitable for new purposes. Among the substances which will be examined are fibres, silk and silk substitutes, drugs, tobacco, gums and resins, minerals, oils, oil-seeds and perfumery, dyes, mordants and pigments, timbers, tanning materials and leather, and food-stuffs. Any visitors to the Exhibition, who are interested in the subject, will be permitted to attend these examinations of products, which will take place in the Commercial Room, attached to the Economic Court, where all further information may be obtained. Should the results of this examination render such a course desirable, Conferences of a formal character will probably be held at a later date.

THE International Society of Electricians has decided upon building laboratories for the use of physicists in Paris. They will be established in the grounds of the old Collège Rollin, granted by the city of Paris, in the vicinity of the School of Practical Physics recently erected by the Municipal Council. The funds will be supplied by public subscription, a contribution from the Society, and a sum of 360,000 francs, which is the surplus of the last Electrical Exhibition organised by M. Cochery.

WE take the following from *Science*:—It will be remembered that in the month of May a gentleman in Brooklyn died from hydrophobia. His medical attendants, competent physicians, had no doubt about their diagnosis, and his symptoms were characteristic of that disease. Confirmatory of this opinion, the autopsy revealed no lesion to which could be attributed the symptoms from which he suffered—a condition which is also characteristic of hydrophobia. Portions of the brain and the spinal cord were carefully wrapped in cloth wet with a solution of bichloride of mercury and sent to Dr. Sternberg. Small portions of these were thoroughly mixed with sterilised bouillon; and this broth was then, by means of a hypodermic syringe, injected under the dura mater covering the brain of a rabbit, a small button of bone having been first removed by a trephine. The wound was then closed by sutures. Three rabbits were thus operated upon. One died at the end of twenty-four hours as the result of the operation; hydrophobia, of course, having nothing to do with it. Another is now, after eighteen days, apparently well. The third one, on the sixteenth day, commenced to show signs of being ill: he was disinclined to move, and in a few hours evidences of paralysis appeared, at first in the hind-legs, and subsequently in all the extremities. On June 5, the eighteenth day after the operation, he died. The wound had healed, and there were no evidences of inflammation. The brain showed no softening at the point where the inoculation was made, no pus, nor any evidences of inflammation either of the brain substance or of its membranes. The cord also appeared normal. Portions of the medulla of this rabbit were immediately mixed with sterilised bouillon, and two rabbits were inoculated in the same manner as has been described. This case is of great interest as being, so far as we know, the first animal in this country to become affected with hydrophobia from inoculation with material taken from a person who died from that disease. If Dr. Sternberg is as successful with these rabbits as with the first, there is no reason why the series cannot be continued, and thus the protective virus of Pasteur be obtained in this country, and a trip to Paris by the victims of dog-bites made unnecessary. As we go to press we learn that the second rabbit, mentioned above as remaining unaffected for eighteen days, shows unmistakable signs of hydrophobia.

DR. THORNTON, the new Director of the Madras Museum, has organised a series of investigations for the purpose of studying systematically the marine and terrestrial fauna on the west coast of the Presidency. They will be continued from time to time as favourable opportunities arise.

AT 8.40 a.m. on May 17 a remarkable phenomenon was witnessed at Dönnæs, in the north of Norway, some twenty five miles south of the Polar Circle. A small bright horizontally-lying circle was suddenly seen with its centre right in zenith, the periphery passing through the centre of the sun. In the circle were besides four mock suns, in east, west, north, and south, so that they would almost have formed the corners in an irregular square. There was also another circle perpendicular on the other, and with the sun as centre, but it was much fainter. The little circle and the two mock suns nearest the sun were rainbow-coloured, and the great circle and the two mock suns furthest off intense white. After half an hour the phenomenon faded for a while, but soon again became as intense as before. It disappeared after having been in view for an hour and a half. The weather was fine and sunny, but hazy. Afterwards it became cloudy with rain.

THE large zoological collection known as the Museum Godeffroy has just been purchased by Mr. Damon (Weymouth). The ethnological portion was sold a short time since to the Leipzig Museum, as already announced in NATURE.

IN addition to the specially meteorological results contained in the report of the Hong Kong Observatory for the past year,

which we noticed last week, Dr. Doberck, the Government Astronomer there, refers to the great value of the systematic meteorological observations with verified instruments which have lately been set on foot at many of the stations and lighthouses of the Chinese Customs, and which will serve as an important aid in the investigation of typhoons. He pays a well-deserved tribute to Japan's "extensive meteorological service, conducted on approved principles," and to the useful weather maps issued by the Tokio Observatory, while he deplores the absence of a similar comprehensive service in the Philippines and the non-publication of such data as are observed there—an omission which increases the labour of following typhoons in their passage across or near to those islands. The intention of the French authorities to establish a meteorological observatory at Haiphong, on the coast of Tonquin, seems to have been dropped, at least for a time, since the death of the distinguished meteorologist, Dr. Borius. The Hong Kong Observatory during the year was supplied with a gazing-telescope, as was recommended by Col. Palmer in the original project, a Lee equatorial from Greenwich having been erected. In 1882, when the plan of the Hong Kong Observatory was first drawn up, the local Government was willing to pay for one thoroughly equipped, but the Colonial Office at home cut out the most important part of the provision for magnetic research, and this unfortunate spirit of parsimony in expenditure connected with scientific research seems now to have extended to Hong Kong. For Dr. Doberck complains that the addition to the work of his Observatory is not accompanied by a corresponding increase of funds and staff, that his telegraphic facilities are insufficient to give full effect to the proper purposes of the establishment, that the slopes of the observatory hill have been left unturfed since they were stripped in 1883, and that no effective measures have been taken to improve the unhealthiness of the site, which is on the Kowloon peninsula opposite the town of Victoria. It sounds incredible that the gun which was supposed to be set apart for the purpose of announcing the approach of a typhoon has also been used to announce the arrival of the mail-steamers—a course which is as senseless as it is cruel, for it confuses the unfortunate boat- and junk-men who swarm in the Hong Kong waters, and who either throw up their work and flee into a place of refuge when only a mail-steamer is arriving, to their great loss of time and money, or they take no precautions at all when a typhoon is really at hand. In the latter case, if any lives were lost, an English coroner's jury would probably indict the official responsible for this gross negligence for manslaughter, as they would the chemist who carelessly gives strychnine in place of Epsom salts. Dr. Doberck proposes that, if the gun be used for post-office purposes, it should cease altogether as a typhoon warning.

AT the annual meeting of the Chemical Society of Tokio, held on April 10, and reported in the *Japan Mail*, a very satisfactory report was read. The Society is composed of Japanese and foreign men of science, the total number of members last year being eighty-six, and being constantly on the increase. The number of papers read amounted to nineteen. The journal of the Society is published four times a year, and it is hoped to make it a monthly journal soon, "especially as the number of papers read is not few, nor their nature inferior to those which appear in foreign journals." The Society undertook to translate chemical terms into Japanese about four years ago, and it now possesses (though not yet published) a dictionary of commoner chemical terms in Japanese, English, French, and German. It has also undertaken to establish a system of chemical nomenclature in the Japanese language, of which the nomenclature of the elements and of inorganic compounds is already nearly finished. It is hoped that a sound and complete system of nomenclature will be published in the course of the coming year. An address was delivered by Mr. Watanabe, the head of the new University of Japan, and, on other grounds, an important official, who impressed on the members of the Society the necessity of making chemistry popular, on account of its intimate connection with arts and manufactures. He hoped, too, that more and more original work in science would be done in Japan, for on such work depended ultimately all improvement in manufacturing processes.

AT the same meeting a paper was read by Dr. Kellner on the deportment of urea towards soils, with special reference to the mode of manuring the soil employed in China and Japan. The experiments on this subject which have been carried out at the Komaba Agricultural College show that the application of fresh excreta is injurious to crops, and that, in this state, a great deal of the most valuable nitrogenous compounds of the manure is lost by rain, which carries the urea into the deep subsoil beyond the reach of the roots of the plants. Japanese farmers had long ago come to a similar conclusion for themselves, for they only employed this manure when in a highly decomposed state, when the urea had been converted by putrefaction into ammonium carbonate.

THE report of the Rugby School Natural History Society for the past year is a very satisfactory one, for it shows great activity on the part of the members and of the Society collectively in every direction. With a single exception the papers are contributed by working members or associates; the collection of British quadrupeds commenced last year is almost complete, and a new vivarium has been added to the Society's resources. The papers deal with many subjects from China to heraldry, but local ornithology appears to have received special attention; for the Society's first prize essay was won by Mr. Austen with a paper on the water-birds of Rugby; the second by Mr. Mander, on some of the large birds round Rugby. Mr. Solly also contributes an interesting paper on microscopic fungi, with illustrations. But it is in the sectional reports that the activity of the Society is made most manifest. Here we find a meteorological report, based on continuous observation throughout the year; a vivarium report; a report from the entomological section, containing a list of the Lepidoptera observed at or near Rugby during the year; similarly the report of the botanical section contains a long list of observations, in which are some plants hitherto unknown in the flora of Rugby; the zoological report, it may be added, is a specially long one; and the book concludes with the report of the Temple Observatory, where so much good astronomical work is being done. Of the many excellent natural history societies which pass under our notice from time to time, few can show more or better work than the Rugby School Society.

ONE interesting matter referred to in the report just noticed was the presentation of an address of congratulation to Mr. M. H. Bloxam, a very energetic member of the Society, on reaching his eightieth year. In his reply Mr. Bloxam claimed to be, in a peculiar degree, a link between the Rugby of the present and that of the past. He transacted business with a Rugbeian who entered the school in the reign of George II., 127 years ago. Mr. Bloxam entered Rugby School about 72 years ago, and left it 64 years ago: and while he was at the school a retired master died who was born in 1718, early in the reign of George I., 167 years ago. The Rev Henry Holyoak was master of the school in the boyhood of that retired old master, and Mr. Holyoak was alive in the lifetime of a nephew of Lawrence Sheriff, the founder of Rugby School. Now Lawrence Sheriff died 318 years ago. Thus three lives, one of them being Mr. Bloxam's, carry us back to the foundation of Rugby School.

We are requested to state that the annual Students' *Conversazione* will take place at the Finsbury Technical College on Friday evening, July 2, commencing at 7 o'clock. A good exhibition of apparatus, models, and specimens has been arranged to illustrate the various branches of applied science and art comprised under the College scheme of technical education.

A Swedish geologist, Dr. H. Sjögren, is about to proceed to the naphtha regions on the Caspian Sea, in order to prosecute geological studies.

We have received from Messrs. Griffin and Co. the third annual issue of the "Year-Book of the Scientific and Learned Societies." It gives a brief chronicle of the work done during the year by the various Societies, together with the necessary information as to official changes.

The Saghalien Ainos do not exhibit the same uncouthness as those of Yezo; there is a greater absence of beards and of hairy bodies generally. The hue of the skin very closely resembles that of the Caucasian; the foreheads are high but narrow, and their general bearing and facial expression denote an intelligence much superior to that of the Yezoines. As for the theory of an ethnical connection between the Ainos and the Japanese, Mr. Penhallow says that an examination of the pure types would not permit such a belief to be entertained. There is a mixture of the two in places, but the half-breed is as easily recognisable there as elsewhere in the world. The Japanese, he concludes, are unquestionably Mongoloid, while the facts show the Ainos to be physically distinct, while the best authorities agree in the great resemblance which they bear to Europeans, the prevailing view being that they are distinctly Aryan.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mrs. George Willing; two Tcheli Monkeys (*Macacus tcheliensis* ♂ ♀) from Jung-ling, near Pekin, presented by Dr. S. W. Bushell, C.M.Z.S.; a Wild Swine (*Sus scrofa* ♀) from Tangier, presented by Mr. John Brooks; four Sparrow Hawks (*Accipiter nisus*), British, presented by Mr. J. Rowland Ward, F.Z.S.; an Egyptian Goose (*Chenalopex ægyptiaca*), a Robben-Island Snake (*Coronella phocarum*), a Hoary Snake (*Coronella cana*), an Infernal Snake (*Boodon infernalis*), a Rhomb-marked Snake (*Psammophylax rhombeatus*), a Horned Viper (*Vipera cornuta*), eight Geometric Tortoises (*Testudo geometrica*), a Leopard Tortoise (*Testudo pardalis*), three Areolated Tortoises (*Homopus areolatus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Crowned Horned Lizard (*Phrynosoma coronatum*) from California, presented by Mr. S. Upton Robins; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Tuatera Lizard (*Sphenodon punctatus*) from New Zealand, presented by Capt. R. Sutherland; a Tarantula Spider (*Mygale*, sp. inc.) from Bahamas, presented by Mrs. E. Blake; a Peruvian Thicknee (*Œdicnemus superciliaris*) from Peru, two White-backed Piping Crows (*Gymnorhina leuconota*) from Australia, deposited; a Balearic Crane (*Balearica pavonina*) from West Africa, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

The Absorption Spectrum of Oxygen.—About three years ago M. Egoroff was able to show that the great groups A and B in the solar spectrum were due to the absorption of oxygen. More recently the α band was also found to be due to the same gas. M. Janssen, studying the absorption of oxygen has now discovered that under certain conditions the gas yields another spectrum, composed no longer of lines easily separated, but of shaded bands which can only be resolved with great difficulty. This system of bands appears for moderate pressures much later than the spectrum of lines, but it shows itself very quickly with increase of the density: the two systems are so different that it is possible to obtain either the first without the second or *vice versâ*. M. Janssen was at first unable to explain how it was that these bands were not visible in the solar spectrum when they were easily obtained by passing light through thicknesses of oxygen far less than the sun's light has to traverse before reaching us. But further experiments showed that these bands did not develop in proportion to the thickness of the stratum of oxygen producing them, multiplied by its density, but in proportion to the thickness multiplied by the square of the density. The density of our atmosphere being small as compared with some of the pressures at which M. Janssen worked, the non-appearance of these bands amongst the telluric lines of the solar spectrum is readily explained.

Potsdam Observatory.—The fifth volume of the *Publications* of the Astrophysical Observatory of Potsdam is occupied with a very careful determination, by Drs. Müller and Kempf, of the wave-lengths of 300 of the principal lines in the solar spectrum. Four gratings were used in this inquiry—one with about 2500 lines to the inch, the second with 6250 lines, and the third and fourth with about 10,000 lines to the inch. Eleven normal lines were first measured with all four gratings and in the spectra of three or four orders with each grating, every observation being carefully corrected for temperature, &c. The computation of the wave-lengths of the 300 lines follows, and the details of the reduction of the observations of the eleven normal lines, and a catalogue of the wave lengths of 2614 lines as given in the Potsdam Atlas of the spectrum, and as now corrected, concludes the work. The following are the wave-lengths of the selected normal lines, expressed in millionths of a millimetre:—C, 656·314, 640·035, 612·247; D_2, 589·625, 562·475, 545·580; b_2, 517·284, 495·770, 470·321, 441·534, and 407·186. It would seem from these determinations that Ångström's wave-lengths require small but sensible corrections.

The Binary Star γ Coronæ Australis.—With reference to our note on this double star (Nature, vol. xxxiii. p. 425), in which we pointed out the large difference in the position-angles computed, for the present year, from the orbit of Mr. Gore and from that of Mr. Downing, we may draw attention to a communication by Mr. H. C. Wilson, of the Cincinnati Observatory, printed in the *Observatory*, No. 111, pp. 234–235. Mr. Wilson gives the mean results of observations of the binary in 1881 and 1883 as follows:—

1881·72	...	...	...	45°·53	1″·38
1883·62	...	...	...	37·75	1·62

The angles computed from Mr. Gore's elements for these two epochs are respectively 47°·29 and 36°·49, which may be regarded as agreeing fairly well with the observations. It appears, therefore, that of the two orbits referred to above, Mr. Gore's is by far the most satisfactory.

Observations of the Companion of Sirius.—Prof. Young has communicated to the *Sidereal Messenger* (No. 46, p. 182) a series of measures of the companion of Sirius made at Princeton, for the most part with the 23-inch refractor, with powers of 460 and 300. Prof. Young remarks that during the present year the companion has been a difficult object, except when the seeing was good, and there have been fewer good nights than usual. The mean annual results are:—

Position-Angle			Distance		
Epoch	Measure	No. of nights	Epoch	Measure	No. of nights
1883·105	39°·0	1	1883·105	9″·41	1
1884·273	36·30	5	1884·270	8·70	4
1885·112	34·06	7	1885·089	8·09	8
1886·047	29·77	4	1886·049	7·59	3

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *JUNE* 27—*JULY* 3

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 27

Sun rises, 3h. 47m.; souths, 12h. 2m. 44·1s.; sets, 20h. 19m.; decl. on meridian, 23° 20′ N.: Sidereal Time at Sunset, 14h. 42m.

Moon (three days after Last Quarter) rises, 1h. 6m.; souths, 7h. 59m.; sets, 15h. 4m.; decl. on meridian, 9° 31′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	5 1	13 17	21 33	23 25 N.
Venus ...	1 42	9 18	16 54	17 22 N.
Mars ...	11 20	17 30	23 40	1 11 N.
Jupiter...	11 17	17 31	23 45	2 3 N.
Saturn...	4 16	12 26	20 36	22 34 N.

June	h.	
28	10	Mars in conjunction with and 0° 59′ south of Jupiter.
29	0	Venus in conjunction with and 2° 57′ north of the Moon.
July 2	16	Sun at greatest distance from the Earth.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	June 29,	0 54	*m*
S Leonis	11 5·0	6 5 N.	July 3,		*M*
δ Libræ	14 54·9	8 4 S.	,, 3,	23 6	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 1,	3 46	*m*
			,, 1,	23 53	*m*
X Sagittarii	17 40·4	27 47 S.	,, 3,	2 0	*M*
R Scuti	18 41·6	5 50 S.	June 27,		*m*
R Lyræ	18 51·9	43 48 N.	,, 28,		*m*
η Aquilæ	19 46·7	0 43 N.	July 1,	0 0	*m*
R Vulpeculæ	20 59·3	23 22 N.	,, 1,		*M*
δ Cephei	22 24·9	57 50 N.	June 29,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

The principal radiants of the season are:—Near β Ursæ Majoris, R.A. 164°, Decl. 57° N.; near ζ Ursæ Majoris, R.A. 210°, Decl. 55° N.; near ξ Serpentis, R.A. 263°, Decl. 15° S.; from Vulpecula, R.A. 302°, Decl. 27° N.; near ζ Pegasi, R.A. 338°, Decl. 13° N.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
R Aquilæ	19 0 32	8 3·4 N.	III.
R Sagittarii	19 9 59	19 30·4 S.	III.
229 Schjellerup	19 25 33	76 20·1 N.	IV.
228 Schjellerup	19 27 46	16 37·2 S.	IV.
R Cygni	19 33 45	49 56·6 N.	III.
D.M. + 32°·3522	19 36 34	32 21·1 N.	IV.
χ Cygni	19 46 11	32 37·5 N.	III.
D.M. + 43°·3425	19 53 31	43 57·3 N.	IV.
D.M. + 35°·4001	20 5 46	35 49·5 N.	Bright lines
D.M. + 35°·4002	20 6 6	35 36·8 N.	IV.
D.M. + 35°·4013	20 7 24	35 50·6 N.	Bright lines
D.M. + 36°·3956	20 10 4	36 17·8 N.	Bright lines
D.M. + 15°·4172	20 23 54	15 53·7 N.	III.
D.M. + 17°·4370	20 32 52	17 52·0 N.	III.
V Cygni	20 37 37	47 44·1 N.	IV.
D.M. + 17°·4401	20 40 15	17 40·6 N.	III.

SECOND ANNUAL REPORT OF THE COUNCIL OF THE MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM[1]

I. THE Council has met during the past year nine times, viz. on October 5, October 27, December 14, March 19, March 25, April 5, April 9, May 19, and June 7. The chief business which has occupied the Council during the past year has been the preparation of the plan of the Laboratory building now in course of erection on the Citadel Hill at Plymouth, and the arranging for the execution of this plan by building and engineering firms. Further, the Council has given much time and attention to negotiations with the Lords of Her Majesty's Treasury with regard to a grant in aid of the objects of the Association.

The most important facts which the Council has to communicate to the Association as the result of the year's work are:—

(1) The undertaking on the part of the Lords of the Treasury to submit to Parliament a grant of 5000*l.*, to be paid in two yearly instalments, and 500*l.* a year for five years, in aid of the objects of the Association; and

(2) The formal approval by the Council of a contract by Mr. Berry, of Plymouth, to erect the buildings and construct the reservoir of the Plymouth Laboratory at the price of 5902*l.* 16*s.*, and also of a contract by Messrs. Leete, Edwards, and Norman, of London, to construct and fit the aquariums and pumping apparatus for the Plymouth Laboratory at the price of 3000*l.*

The excavation of the site on the Citadel Hill at Plymouth is now actually in progress, and the Laboratory will be in all probability ready for occupation by this time next year.

In June 1885, the Council reported a capital sum of nearly 8000*l.* as definitely promised to the Association, of which 4787*l.* was in the hands of the Treasurer.

The Council now has to report a capital sum of 10,000*l.* available for expenditure on the building and fitting of the Plymouth Laboratory, and in addition an annual income from investments and annual subscriptions of 1100*l.* a year. Of the disposable capital sum about 5000*l.* is in the hands of the Treasurer, whilst the sum of 5000*l.* is to be paid in two instalments, one in 1886, and one in 1887, by Her Majesty's Treasury.

In June 1885, the Association numbered 277 members, of whom 163 were annual subscribers, the rest having compounded. It now numbers 305 members, of whom 169 are annual subscribers.

Amongst important donations to the Association made during the past year, the Council desire especially to mention the sum of 500*l.* received from Mr. John Bayly, of Plymouth, who was already a Founder, and is now qualified as a Life Governor of the Association. On hearing that the Council felt it to be necessary to omit certain features in the plan of the Plymouth Laboratory as approved by them, on account of the expense involved, Mr. John Bayly came forward with this munificent donation, and thus enabled the Council to carry out their original design.

II. In reference to the grant from the Treasury, the Council submit, for the information of the members of the Association, the final letter received from the Lords of the Treasury and the answer returned by the Council to that communication.

Treasury Chambers, December 9, 1885

SIR,—I have laid before the Lords Commissioners of Her Majesty's Treasury your letters of the 2nd and 13th ultimo, on the question of the proposed assistance to be given by the Government to the Marine Biological Association of the United Kingdom. Their Lordships have considered the matter very carefully, and they now desire me to inform you that they are prepared to propose to Parliament a grant of 5000*l.* towards the cost of the Laboratory which the Association intends to construct at Plymouth, such grant to be paid in two instalments of 2500*l.* each, one in 1886-87, and the other in 1887-88, and also an annual grant of 500*l.* for five years, beginning in the year 1887-88, towards the current expenses of the Laboratory, on the following conditions:—

(1) That the Council of the Association agrees to have its accounts formally audited each year, and to furnish a statement of income and expenditure to the Treasury.

(2) That the Council undertakes to issue at regular intervals (probably half-yearly) a detailed report of the work done in the Plymouth Laboratory, and to furnish the Treasury with such report.

(3) That the Council pledges itself definitely to aim at procuring practical results with regard to the breeding and management of food-fishes.

(4) That the Council undertakes to place space in the Plymouth Laboratory at the disposal of any competent investigator deputed by a recognised authority to carry out any investigation into fish questions for which the Laboratory can give facilities.

I am to add that my Lords will make the necessary provision for these grants in the Estimates for the coming year, but until Parliament shall have sanctioned the grant, it will not be in their power to make any payments to the Association in fulfilment of the above promise of assistance.

In conclusion I am to suggest, with reference to your letter of the 8th instant, that in future any communications between the Association and the Scotch Fishery Board should be conducted through the Secretary for Scotland.

I have the honour to be, Sir, your obedient servant,

M. W. RIDLEY

[1] Presented to the Annual General Meeting of the Association on June 8, 1886, Prof. Huxley, President of the Association, in the chair.

SIR,—I have laid before the Council of the Marine Biological Association your letter of the 7th inst., and I am instructed by the Council to say that they accept the four conditions mentioned in your letter as those upon which the Lords Commissioners of Her Majesty's Treasury are prepared to propose to Parliament a grant of 5000*l*., and an annual grant of 500*l*. a year for five years, in aid of the building and of the current expenses of the Laboratory about to be erected by the Association on Plymouth Sound.

The Council of the Association desire me to express, through you, to my Lords, the gratification which they experience in receiving this important assistance and mark of confidence from my Lords, and to offer at the same time their thanks to my Lords for the favourable consideration which has been accorded to the request of the Council.

In regard to the term "a recognised authority" used in the fourth condition proposed by my Lords and accepted by the Council, I am directed to say that the Council assumes that a "recognised" authority means a "STATE" recognised authority, such as the Scotch Fishery Board or Her Majesty's Inspectors of Fisheries.

On behalf of the Council of the Marine Biological Association I am accordingly empowered to state—

(1) That the Council agrees to have its accounts formally audited each year, and to furnish a statement of income and expenditure to the Treasury.

(2) That the Council undertakes to issue at regular intervals (probably half-yearly) a detailed report of the work done in the Plymouth Laboratory, and to furnish the Treasury with such report.

(3) That the Council pledges itself definitely to aim at procuring practical results with regard to the breeding and management of food-fishes.

(4) That the Council undertakes to place space in the Plymouth Laboratory at the disposal of any competent investigator deputed by a recognised authority to carry out any investigation into fish questions for which the Laboratory can give facilities.

I have the honour to be, Sir, your obedient servant,

E. RAY LANKESTER, Hon. Sec. M.B.A.

To Sir M. W. Ridley, Bart.

III. The attention of the Council having been drawn to the statement made in the House of Commons by the President of the Board of Trade to the effect that it was the intention of the Government to constitute a Fisheries Department under that Board, the following letter was addressed on March 19 to the President of the Board of Trade:—

April 7, 1886

SIR,—I am desired by the Council of the Marine Biological Association to inform you that they have observed from an official statement in Parliament that it is the intention of Her Majesty's Government to constitute a Fishery Department as a branch of the Board of Trade. With a view to the meeting of the Council of the Association on March 19 last, I took the liberty to inquire whether you would be disposed to receive a deputation from the Council in order that it might have an opportunity of placing before you some account of the origin of the Association and of its proposed operations with regard to the fisheries of the British seas. The Council having learned that you thought the reception of such a deputation inadvisable, have instructed me to communicate to you, in accordance with your invitation, a brief account of the position of the Association and of its relations to the Government.

The Council have taken steps to erect on the Citadel Hill, at Plymouth, on a site granted by the War Office, a Laboratory, which will be equipped with all the appliances in the shape of tanks and working rooms suited for the study and observation of fishes and other marine organisms. It will afford convenient accommodation for from sixteen to twenty scientific investigators qualified to engage in biological research.

In view of the national utility of such a Laboratory in connection with the fishing industry, the Lords Commissioners of Her Majesty's Treasury have agreed to submit to Parliament a vote of 5000*l*., in two annual instalments, towards the erection of the Laboratory, and to supplement this when the Laboratory has been completed by an annual subsidy of 500*l*.

I am directed to annex for your information a copy of the letter from my Lords embodying these undertakings. You will observe that they have laid stress on the duty of the Association to investigate everything relating to the economy of food fishes, and that they further desired that the Marine Biological Association should work in harmony with the Scotch Fishery Board, which was, at that time, the only formally constituted body connected with the subject in Great Britain.

The Council apprehend, therefore, that the Marine Biological Association, receiving as it does liberal support and recognition of the importance of its aims from the Government, should place at the disposal of the new Fishery Department any resources it may possess for the prosecution of such scientific investigations as the Department may wish to initiate.

The Council further desire me to say that they will be glad to enter into such relations with the Department as may seem to you best calculated to effect the object.

In making this offer the Council believe that they are carrying out the spirit of the conditions imposed upon them by my Lords in the letter of which a copy is inclosed.

I am, Sir, your most obedient servant,

E. RAY LANKESTER, Hon. Sec. M.B.A.

The Right Honourable A. J. Mundella, M.P.,
Board of Trade

To this letter the following answer was received:—

Board of Trade, Whitehall Gardens, S.W.,
April 8, 1886

SIR,—I am directed by Mr. Mundella to acknowledge the receipt of your letter of April 7, and to request that you will be so good as to convey to the Council of the Marine Biological Association his best thanks for their kind offer which they have made to place at the disposal of the new Fishery Department the resources which they possess for the prosecution of such scientific investigations as the Department may wish to initiate. Mr. Mundella wishes me to add that the matter is now receiving his most careful consideration.

I am, Sir, your obedient servant,

Prof. E. Ray Lankester T. W. P. BLOMEFIELD

IV. In reference to the building and aquarium fittings, which have been approved, and are now in course of construction for the Laboratory at Plymouth, the Council appointed, as stated in the last Annual Report, a Committee consisting of the Treasurer, the Secretary, Dr. John Evans, Prof. Moseley, and Mr. Spence Bate. These gentlemen, assisted by Mr. Walter Heape, Assistant Secretary, and by Mr. Inglis, civil engineer, of Plymouth, met on several occasions in order to consider the details of the Laboratory building and its fittings. Information and advice was obtained from the directors of the existing laboratories and aquariums in Europe and in the United States of America, as well as from engineering firms acquainted with the special kind of work required. The limitation of the funds at the disposal of the Council had to be strictly borne in mind by the Committee, and finally, after much deliberation, a plan of buildings and fittings was submitted by the Committee and approved by the Council. The approval of the War Office had to be obtained in regard to the design of the building which is to be erected on the site granted by that Department of State, and the Council has had the advantage in this connection of the advice and assistance of Mr. E. Bell, the architect to the War Office. The design, for which a contract has now been accepted by the Council, has the approval of the authorities of the War Office and of the Town Council of Plymouth.

V. Shortly after the annual meeting in June 1885, Mr. St. Leger Bunnett, of New Stone Buildings, 60, Chancery Lane, was appointed Assistant Secretary with the special purpose of aiding the Secretary in obtaining subscriptions and donations.

In January of the present year Mr. Walter Heape vacated his post of Assistant Secretary, and was appointed Resident Superintendent of the Plymouth Laboratory at a salary of 200*l*. a year. Mr. Heape will be provided with a suite of apartments in the Laboratory building. Since his appointment Mr. Heape has visited the Zoological Laboratory at Naples for the purpose of acquiring information which may assist him in the management of the Plymouth Laboratory. He will at once proceed to Plymouth and take up his residence there, in order to commence an investigation of the natural history of Plymouth Sound and to enter into relations with the fishermen of the district, so as to prepare the way for the operations of the Laboratory when completed. Mr. Heape will also watch the erection of the Laboratory building and report from time to time to the Council of the Association at Plymouth.

VI. The Council propose to make two alterations in the

by-laws of the Association which will require the approval of the present general meeting and of a subsequent special general meeting, which will be duly summoned. The first proposal is to enact by by-law of the Association that the Prime Warden of the Fishmongers' Company shall always be *ex officio* a member of the Council of the Association. The Fishmongers' Company have shown their interest in the enterprise of the Association by contributing 2000*l*. to its funds. In reply to an inquiry from the Council, the Court of Assistants of the Fishmongers' Company have cordially accepted the proposition that the Prime Warden of the Company should hold the official relation to the Association above proposed. The Council therefore propose to alter By-law 2 of the Association by the insertion between the words "officers" and "and fourteen other members" of the words "the Prime Warden of the Fishmongers' Company for the time being."

The second proposal has relation to the admission of the Universities of Great Britain and Ireland to a share in the government of the Association. As was stated in the last Annual Report, members of the University of Cambridge have subscribed a sum of 500*l*. for the purpose of qualifying the University as a Governor of the Association. During the past year a similar fund has been raised by members of the University of Oxford. At the annual general meeting in June 1885, in view of these proceedings, the following addition to By-law 17 was carried: "Any University of the United Kingdom, on the payment of 500*l*. to the Association by members of the University, shall, if the Council of the Association consent thereto, acquire as a consequence the perpetual right of nominating one member of the Council of the Association."

The Council now propose to erase the words just cited, and to substitute the following:—

"Any University of the United Kingdom, on the payment of 500*l*. to the Association in the name of the University and for the purpose of acquiring the right herein specified, shall, if the Council of the Association assent thereto, become a Governor of the Association, and acquire the perpetual right of nominating annually one member of the Council of the Association to serve for one year (from the annual meeting in one year to that in the following year); and any resident member of the University subscribing 100*l*. or more to such fund of 500*l*., shall, in virtue of such subscription, become a 'Founder' of the Association."

VII. The Council have again to record a severe loss to the Association in the list of its Vice-Presidents owing to the death of Dr. W. B. Carpenter, C.B., F.R.S. Dr. Carpenter was a warm supporter of the Association, and contributed largely by his advocacy of its objects to the success which has now been attained.

VIII. The Council do not propose any change in the list of Officers, Vice-Presidents, and Council for the ensuing year. They desire to notify that the following gentlemen have qualified by subscription of 500*l*. each as Life-Members (Governors) of the Council, viz. Mr. Robert Bayly, of Plymouth, 1885; Mr. Bazley White (Clothworkers' Company), 1885; Mr. E. L. Beckwith (Fishmongers' Company), 1885; and Mr. John Bayly, of Plymouth, 1886.

IX. During the ensuing year the building at Plymouth will be in course of erection. It is anticipated that the chief duty of the Council during this period will be to organise a scheme of investigation to be carried out at Plymouth when the Laboratory is in working order.

It will be especially the business of the Council to determine the conditions under which the Laboratory shall be accessible to the naturalists of the United Kingdom and other countries for the purpose of aiding in those inquiries into the life-history of marine animals and plants, and particularly of food-fishes, which it is the purpose of the Association to foster.

X. The plan of the Laboratory building includes a library. The Council take the present opportunity of asking for donations of works relating to fisheries and to marine zoology and botany for the library. They will also be glad to receive subscriptions towards a special library fund, in reference to which and all similar matters, the Hon. Secretary, Prof. Lankester, can be consulted.

XI. In conclusion, the Council desire again to express the great obligation which the Association is under towards the Council of the Linnean Society for the continued permission accorded by that body to the Association to meet in the rooms of the Society.

MEMORANDUM RELATING TO THE MODE IN WHICH SCIENTIFIC KNOWLEDGE CAN BE MADE USEFUL TO ENGLISH FISHERIES

THE following Memorandum has been presented to the President of the Board of Trade and officially acknowledged by him:—

Without committing ourselves to all the statements and opinions contained in the subjoined Memorandum, we, the undersigned, wish to state that we concur generally with the views as to the proposed constitution of the new Fishery Department therein expressed—

Argyll, K.G., F.R.S.; Walsingham; Stalbridge; E. Marjoribanks, M.P., Member of the late Royal Commission on Trawling; John Lubbock, Bart., M.P., F.R.S.; James Paget, Bart., F.R.S.; Henry W. Acland, K.C.B., F.R.S.; J. Fayrer, K.C.S.I., F.R.S., Honorary Physician to the Queen, Physician to the Secretary of State for India in Council; C. Spence Bate, F.R.S., Member of Council of the Marine Biological Association; I. Bayley Balfour, F.R.S., Sherardian Professor of Botany in the University of Oxford; Ed. Lonsdale Beckwith, late Prime Warden of the Fishmongers' Company, Member of Council of the Marine Biological Association; F. Jeffrey Bell, F.Z.S., Professor of Zoology in King's College, London, Member of Council of the Marine Biological Association; Henry B. Brady, F.R.S.; W. S. Caine, M.P., Member of the late Royal Commission on Trawling; P. H. Carpenter, F.R.S.; W. H. Dallinger, F.R.S., President of the Royal Microscopical Society; F. Darwin, F.R.S.; W. T. Thiselton Dyer, C.M.G., F.R.S., Director of the Royal Gardens, Kew, Member of Council of the Marine Biological Association; W. H. Flower, F.R.S., Superintendent of the British Museum, Natural History, President of the Zoological Society, Vice-President of the Marine Biological Association; Hans Gadow, Strickland Curator and Lecturer on Animal Morphology in the University of Cambridge; Arthur Gamgee, F.R.S., Fullerian Professor of Physiology in the Royal Institution of Great Britain; W. H. Gaskell, F.R.S.; A. Günther, F.R.S., Keeper of the Zoological Department of the British Museum, Member of Council of the Marine Biological Association; S. F. Harmer, Fellow of King's College, Cambridge; W. A. Herdman, Professor of Zoology in University College, Liverpool, Member of Council of the Marine Biological Association; G. M. Humphry, F.R.S., Professor of Surgery in the University of Cambridge, late Professor of Anatomy, Fellow of King's College; J. N. Langley, F.R.S., Fellow of Trinity College, Cambridge; E. Ray Lankester, F.R.S., Jodrell Professor of Zoology in University College, London, Fellow of Exeter College, Oxford, Hon. Sec. of the Marine Biological Association; A. Milnes Marshall, F.R.S., Professor of Zoology in Owens College, Manchester, Member of Council of the Marine Biological Association; W. C. McIntosh, F.R.S., Professor of Natural History in the University of St. Andrews, Vice-President of the Marine Biological Association; H. N. Moseley, F.R.S., Linacre Professor of Human and Comparative Anatomy in the University of Oxford, Chairman of Council of the Marine Biological Association; Geo. J. Romanes, F.R.S., Member of Council of the Marine Biological Association; J. Burdon Sanderson, F.R.S., Waynflete Professor of Physiology in the University of Oxford; E. A. Schäfer, F.R.S., Professor of Physiology in University College, London; P. L. Sclater, F.R.S., Secretary of the Zoological Society, Member of Council of the Marine Biological Association; Adam Sedgwick, F.R.S., Fellow of Trinity College, Cambridge, Member of Council of the Marine Biological Association; C. Stewart, F.L.S., Conservator of the Museum of the Royal College of Surgeons, Member of Council of the Marine Biological Association; D'Arcy W. Thompson, Professor of Zoology in University College, Dundee; Sydney H. Vines, F.R.S.; W. F. R. Weldon, Fellow of St. John's College, Cambridge; Frank Crisp, Vice-President of the Linnean Society, Hon. Treasurer of the Marine Biological Association; Peter Eade, President, on behalf of the Norfolk and Norwich Naturalists' Society; J. Gurney, Mayor of Norwich, R. E. Burroughes, H. W. Stafford, John B. Pearce, Harry Bullard, S. Gurney Buxton, and John Barwell, Conservators under the Norfolk and Suffolk Fisheries Act, 1877, for the City of Norwich; C. Louis Buxton, T. C. Blofeld, and E. Frost, Mayor of Thetford, Conservators for Norfolk; B. F. Grimsey, Mayor of Ipswich, and Lieut.-Col. H. M. Leathes, Conservators for Suffolk; F. B. Archer, Conservator for Lynn; C. J. Greene, Hon. Sec. of the

Yare Preservation Society; Lieut.-Col. F. H. Custance; Michael Beverley, M.D.; H. W. Bidwell; G. F. Buxton; H. W. Fielden, late Naturalist to Sir G. Nares's Arctic Expedition; Thos. Southwell.

I.—*Preface*

(1) The necessity for an administration of our marine and fresh-water fisheries based upon thorough or scientific knowledge of all that relates to them has become obvious of late years. The Trawling Commission of 1884–85 has reported to this effect in so far as the subject of their inquiries is concerned. Other nations have adopted such a method of dealing with their fisheries, with good results and the promise of better.

(2) The inquiries and operations necessary cannot be conducted as the result of private commercial enterprise. They must be national in character.

(3) Whilst the general trade returns of the fishing industry, on the one hand, and the practical enforcing of regulations as to the protection of fishing-grounds and the restriction of fishing operations within certain seasons and localities are matters with which an ordinary staff of officials can effectually deal, yet the chief purposes of the operation of a satisfactory Fisheries Department are of such a nature that only expert naturalists can usefully advise upon them and carry them out. It is therefore important that the organisation of a State Fisheries Department should either be primarily under the control of a scientific authority who should direct the practical agencies as to trade returns and police, or that there should be distinct and parallel branches of the Department—the one concerned in scientific questions, the other in collecting trade returns and in directing the fisheries police.

(4) It does not appear that there is any ground for supposing that individuals of scientific training are *ipso facto* unfitted for administrative duties, and there would be obvious advantages in placing the operations of a Fisheries Department under one head. Indeed, it may be maintained that an education in scientific matters, and capacity for scientific work, is likely to produce a more practical and enterprising director of such a Department than could elsewhere be found. It has not been found desirable to place the administration of the important botanical institution at Kew in the hands of a non-scientific director, and there is no obvious reason for avoiding the employment of a scientific staff in the case of a Fisheries Department.

II.—*Nature of the Work to be done*

(1) Generally to ascertain what restrictions or modifications in the proceedings of fishermen are desirable, so as to insure the largest and most satisfactory returns prospectively as well as immediately from the fishing-grounds of the English coast and from English rivers and lakes.

(2) Especially to ascertain whether existing fishing-grounds can be improved by the artificial breeding of food-fishes and shell-fish, and to determine the methods of carrying on such breeding, and to put these methods into practice.

(3) To find new fishing-grounds.

(4) To introduce new fish—either actually new to the locality or new to the consumer.

(5) To introduce (if practicable) methods of rearing and fattening marine fish in stock-ponds.

(6) To look after the cultivation and supply of bait.

(7) To introduce new baits, new methods of fishing, improved nets, improved boats, new methods of transport and of curing.

The work can be divided into two sections. A. Investigation; B. Practical Administration.

A. *Investigation.*—The inquiries which are necessary in order to effect the purposes indicated above are as follows:—

(1) A thorough physical and biological exploration of the British coasts within a certain distance of the shore-line, especially and primarily in the neighbourhood of fishing-grounds. The investigation must include a determination of temperature and currents at various depths, the nature of the bottom, the composition of the sea-water, and the influence of rivers and conformation of coast upon these features. At the same time the entire range of the fauna and flora must be investigated in relation to small areas so as to connect the varying living inhabitants of different areas with the varying physical conditions of those areas and with the varying association of the living inhabitants *inter se*. Only in this way can the relation of food-fishes to the physical conditions of the sea, and to their living associates be ascertained and data furnished for ultimately determining the causes of the local distribution of different kinds of food-fishes and of the periodic migrations of some kinds of them.

(2) A thoroughly detailed and accurate knowledge of the food, habits, and movements of each of the important kinds of food-fishes (of which about five-and-twenty, together with six shell-fish important either as food or bait, may be reckoned). The relation of each of these kinds of fish to its fishing-ground must be separately ascertained; its time and mode of reproduction, the mode of fertilisation of its eggs, the growth of the embryo, the food and habits of the fry, the enemies of the young and of the adult, the relation of both young and adult to temperature, to influx of fresh water, to sewage contamination, to disturbing agencies such as trawling, and ordinary traffic.

(3) An inquiry as to whether over a long period of years there has been an increase or a decrease in the abundance of each kind of food-fish on the chief fishing-grounds as a matter of fact, together with an inquiry as to the actual take of each kind of fish in successive years, and further an inquiry as to any accompanying variation in (*a*) the number of fishing-boats; (*b*) the methods of fishing; (*c*) the climatic conditions or other such possibly influential conditions as previous inquiry may have suggested.

(4) An inquiry for the purpose of ascertaining experimentally whether the decrease in the yield of fishing-grounds, in regard to each several species of food-fish can be remedied: (*a*) by artificial breeding of the fish; (*b*) by protecting the young; (*c*) by increasing its natural food; (*d*) by destruction of its enemies; (*e*) by restrictive legislation as to time or place of fishing and as to size of fish which may be taken and character of fishing apparatus which may be used.

(5) An inquiry to ascertain whether, if periodic, natural causes are at work in determining the fluctuations of the yield of fishing-grounds, their effect can be foretold, and whether this effect can in any case be counteracted; similarly to ascertain in the case of migratory shoal-fish whether any simple and trustworthy means can be brought into operation for the purpose of foretelling the places and times of their migrations so as to enable both fishermen and fish-dealers to be ready for their arrival.

(6) An inquiry into the diseases of fish, especially in relation to salmon and other fresh-water fish.

B. *Practical Administration.*—The chief heads under which this presents itself as distinct from the antecedent search for reliable data are:—

(1) The management of an efficient "intelligence department," giving weekly statistics of the fishing industry, the appearance and disappearance of certain fish at particular spots, the number of fishing-boats employed, the methods of fishing employed, the meteorological conditions.

(2) The advising and enforcing of restrictions by the Legislature as to time, place, and method of capture of fish.

(3) The artificial breeding and rearing of fish to stock impoverished fishing-grounds.

(4) The leasing and management of the foreshore and sea-bottom in particular spots, for the purposes of oyster-culture and mussel-culture, and of marsh-lands near the sea for the formation of tanks and fish-ponds.

(5) The opening up of new fishing-grounds and of new fish industries (curing and treatment of fish for commercial purposes).

(6) The introduction of new species of food-fish and shell-fish.

III.—*General Organisation and Staff necessary to carry on the Inquiries and to put the Results attained into Practice*

It is a matter of fundamental importance to determine, first of all, whether it is desirable that these matters should be dealt with by a permanent staff, or, on the other hand, by the occasional employment of a scientific man—not habitually occupied in these inquiries—to attempt the solution of any particular problem which an unskilled official may present to him.

Clearly there must be economy in employing permanently certain naturalists who will familiarise themselves with this

special class of questions and become experts in all that relates to fishery problems.

Further, is it desirable that the matters which are to be inquired into should be determined by an official unskilled in natural history? Or, on the other hand, that the selection of inquiries likely to lead to a satisfactory result should be made by a man of science, specially conversant with the nature of the things to be dealt with?

The organisation required consists, so far as persons are concerned, of:—

(1) A chief scientific authority.

(2) A staff of working naturalist-inspectors.

(3) A staff of clerks.

And, so far as material is concerned, of:—

(4) A London office, with collection of fishes, apparatus used in fishing, maps, survey-records, statistical returns, and library.

(5) A surveying-ship, under the orders of the Department, to be manned and maintained by the Admiralty.

(6) A chief laboratory fitted for carrying on investigations such as those named in Section II., and also two smaller movable laboratories, together with steam yacht fitted for dredging and sounding.

(7) Hatching-stations and fish-ponds.

With regard to the foregoing headings, it is a matter for consideration whether "the chief scientific authority" should be an individual or a committee of five. The position assigned to this post should be equal to that of the Director of the Geological Survey or the Director of the Royal Gardens, Kew, or, if the "authority" takes the form of a committee, it should be placed on the same footing as the Meteorological Council. The person or persons so appointed should be responsible for all the operations of the Department, and of such scientific training and capacity as to be likely to devise the most useful lines of inquiry and administration.

The "naturalist-inspectors" should be six in number, but operations might be commenced with a smaller staff. They should be thoroughly competent observers, and under the direction of the chief scientific authority they would be variously employed, either on the surveying-ship, at the chief laboratory, or in local laboratories, hatching-stations, or in the London office and museum.

The naturalists thus employed would become specialists in all matters relating to the life-history of fishes and their food; they would acquire a skill and knowledge far beyond that which it is possible to find amongst existing naturalists, who occasionally are requested to make hurried reports on such matters as salmon disease or the supposed injury of the herring-fisheries by trawlers.

One of the naturalist-inspectors should be a chemist and physicist, in order to report on the composition of the water and the nature of the bottom in the areas investigated.

"Clerks" would be required in the London office to tabulate statistics and carry on correspondence. These gentlemen need not necessarily have any scientific knowledge. It would probably be necessary to have a correspondent or agent of the Department in every large fishing centre. Probably the coast-guard officials might be taken into this service.

With regard to material equipment it appears to be necessary that a Scientific Fisheries Department should have at its London office a Museum of fishing apparatus for reference and instruction, and also complete collections illustrative of the fishes, their food, enemies, and other surroundings. In the same building would be exhibited maps showing the distribution and migrations of food-fishes, the coast temperature and its variations, the varying character of the sea-bottom, sea-water, &c.

The surveying-ship or ships would be provided by the Admiralty.

A central laboratory is in course of erection upon Plymouth Sound by the Marine Biological Association. Her Majesty's Government has promised to contribute 5000*l*. and 500*l*. a year to this institution, on condition that its resources are available for the purpose here indicated. Certain of the "naturalist-inspectors" (probably three at any one time) would be stationed at the Plymouth laboratory in order to carry on special studies of the development and food of particular species of fish.

The smaller movable laboratories, steam-yacht, and other appliances would not be costly.

ON NEW APPLICATIONS OF THE MECHANICAL PROPERTIES OF CORK TO THE ARTS[1]

It would seem difficult to discover any new properties in a substance so familiar as cork, and yet it possesses qualities which distinguish it from all other solid or liquid bodies, namely, its power of altering its volume in a very marked degree in consequence of change of pressure. All liquids and solids are capable of cubical compression, or extension, but to a very small extent; thus water is reduced in volume by only 1/2000 part by the pressure of one atmosphere. Liquid carbonic acid yields to pressure much more than any other fluid, but still the rate is very small. Solid substances, with the exception of cork, offer equally obstinate resistance to change of bulk; even india-rubber, which most people would suppose capable of very considerable change of volume, we shall find is really very rigid.

I have here an apparatus for applying pressure by means of a lever. I place a piece of solid india-rubber under the plate and you see that I can compress it considerably by a very light pressure of my finger. I slip this same piece of india-rubber into a brass tube, which it fits closely, and now you see that I am unable to compress it by any force which I can bring to bear. I even hammer the lever with a mallet, and the blow falls as it would on a stone. The reason of this phenomenon is, that in the first place, with the india-rubber free, it spread out laterally while being compressed longitudinally, and consequently the volume was hardly altered at all; in the second case, the strong brass tube prevented all lateral extension, and because india-rubber is incapable of appreciable cubical compression, its length only could not be sensibly altered by pressure.

Extension, in like manner, does not alter the volume of india-rubber. In this glass tube is a piece of solid round rubber which nearly fills the bore. The lower end of the rubber is fixed in the bottom of the tube, and the upper end is connected by a fine cord to a small windlass, by turning which I can stretch the rubber. I fill the tube to the brim with water, and throw an image of it on to the screen. If stretching the rubber either increases or diminishes its volume, the water in the tube will either overflow or shrink in it. I now stretch the rubber to about 3 inches, or one-third of its original length, but you cannot see any appreciable movement in the water-level, hence the volume of the rubber has not changed.

Metals when subjected to pressures which exceed their elastic limits, so that they are permanently deformed, as in forging or wire-drawing, remain practically unchanged in volume per unit of weight.

I have here a pair of common scales. To the under sides of the pans I can hang the various specimens that I wish to examine; underneath these are small beakers of water which I can raise or lower by means of a rack and pinion. Substances immersed in water lose in weight by the weight of their own volume of water; hence if two substances of equal volume balance each other in air, they will also balance when immersed in water, but if their volumes are not the same, then the substance having the smaller volume will sink, because the weight of water it displaces is less than that displaced by the substance with the larger volume. To the scale on your left hand is suspended a short cylinder of ordinary iron, and to the right-hand scale a cylinder of ordinary copper. They balance exactly. I now raise the beakers and immerse the two cylinders in water; you see the copper cylinder sinks at once, and I know by that that copper has a smaller volume per pound than iron, or, as we should commonly say, it is heavier than iron. I now detach the copper cylinder, and in its place hang on this iron one, which is made of the same bar as its fellow cylinder, but forced, while red hot, into a mould by a pressure of sixty tons per square inch and allowed to cool under that pressure. The two cylinders balance, as you see. Has the volume of the iron in the compressed cylinder been altered by the rough treatment it has received? I raise the beakers, immerse the cylinders, the balance is not destroyed; hence we conclude that although the form has been changed the volume has remained the same. I substitute for the hot compressed cylinder one pressed into a mould while cold, and held there for some time, with a load of sixty tons per square inch; the balance is not destroyed by immersion, hence the volume has not been altered. I can repeat the experiments with these copper cylinders and the

[1] A Paper read at the Royal Institution of Great Britain on April 9, 1886, by William Anderson, M.Inst.C.E., M.R.I.

result will be found the same. Extension also is incapable of appreciably altering the density of metals. I attach to the scales two specimens of iron taken from a bar which had been torn asunder by a steady pull. One specimen is cut from the portion where it had not been strained, and the other from the very point where it had been gradually drawn out and fractured. The specimens balance, I immerse them, you see the balance is not destroyed; hence the volume of the iron has not been changed appreciably by extension.

But cork behaves in a very different manner. I place this cylinder of cork into just such a brass tube as served to restrain the india-rubber and apply pressure to it in the same way; you see I can readily compress the cork, and when I release it it expands back to its original volume: the action is a little sluggish on account of the friction of the cork against the sides of the tube. In this case, therefore, a very great change in the volume of the material has been easily effected.

But although solids evidently do not change sensibly in bulk, after having been released from pressures high enough to distort them permanently, yet, while actually under pressure, the volumes may have been considerably altered. As far as I am aware, this point has not been determined experimentally for metals, but it is very easy to show that india-rubber does not change.

I have here some of this substance, which is so very slightly lighter than water, that, as you see, it only just floats in cold water but sinks in hot. If I could put it under considerable pressure while afloat in cold water, then, if its volume became sensibly less, it ought to sink. In the same way, if I load a piece of cork and a piece of wood so that they barely float, if their volumes alter they ought to sink.

In this strong upright glass tube I have, at the top, a piece of india-rubber, immediately below it a piece of wood, and below that a cork; the wood and the cork are loaded with metal sinkers to reduce their buoyancy. The tube is full of water and is connected to a force-pump by means of which I can impose a pressure of over 1000 lbs. per square inch. The image of the tube is now thrown on the screen and the pressure is being applied. You see at once the cork is beginning to shrink in all directions, and now its volume is so reduced that it is incapable of floating, and sinks down to the bottom of the tube. The india-rubber is absolutely unaffected, the wood does contract a little, but not sufficiently to be visible to you or to cause it to sink. I open a stop-cock and relieve the pressure; you see that the cork instantly expands, its buoyancy is restored, and it floats again. By alternately applying and taking off the pressure I can produce the familiar effect so well known in the toy called "the bottle imps." It is this singular property which gives to cork its value as a means of closing the mouths of bottles. Its elasticity has not only a very considerable range, but it is very persistent. Thus in the better kind of corks used in bottling champagne and other effervescing wines you are all familiar with the extent to which the corks expand the instant they escape from the bottles. I have measured this expansion, and find it to amount to an increase of volume of 75 per cent., even even after the corks have been kept in a state of compression in the bottles for ten years. If the cork be steeped in hot water, the volume continues to increase till it attains nearly three times that which it occupied in the neck of the bottle.

When cork is subjected to pressure, either in one direction, as in this lever press, or from every direction, as when immersed in water under pressure, a certain amount of permanent deformation or "permanent set" takes place very quickly. This property is common to all solid elastic substances when strained beyond their elastic limits, but with cork the limits are comparatively low. You have, no doubt, noticed in chemists' and other shops that, when a cork is too large to fit a bottle, the shopkeeper gives the cork a few sharp bites, or, if he be more refined, he uses a pair of specially-contrived pincers; in either case he squeezes the cork beyond its elastic limits, and so makes it permanently smaller. Besides the permanent set, there is a certain amount of what I venture to call sluggish elasticity, that is, cork on being released from pressure, springs back a certain amount at once, but the complete recovery takes an appreciable time.

While I have been speaking, a piece of fresh cork, loaded so as barely to float, has been inserted into the vertical glass pressure-tube. I apply a slight pressure, you see the cork sinks. I release the pressure, and it rises briskly enough. I now apply a much higher pressure for a moment or two, I release it, and the cork will either not rise at all, or will do so very slowly; its volume has been permanently altered; it has taken a permanent set.

In considering the properties of most substances, our search for the cause of these properties is baffled by our imperfect powers and the feeble instruments we possess for investigating molecular structure. With cork, happily, this is not the case; an examination of its structure is easy, and perfectly explains the cause of its peculiar and valuable properties.

All plants are built up of minute cells of various forms and dimensions. Their walls or sides are composed chiefly of a substance called cellulose, frequently associated with lignine, or woody matter, and with cork, which last is a nitrogenous substance found in many portions of plants, but is especially developed in the outer bark of exogenous trees, that is, trees belonging to an order, by far the most common in these latitudes, the stems of which grow by the addition of layers of fresh cellulose tissue outside the woody part and inside the bark. Between the bark and the wood is interposed a thin fibrous layer, which, in some trees, such as the lime, is very much developed, and supplies the bass matting with which all are familiar. The corky part of the bark, which is outside, is composed of closed cells exclusively, so built together that no connection of a tubular nature runs up and down the tree, although horizontal passages radiating towards the woody part of the tree are numerous. In the woody part of the tree, on the contrary, and in the inner bark, vertical passages or tubes exist, while a connection is kept up with the pith of the tree by means of medullary rays. In one species of tree, known as the cork oak, the corky part of the bark is very strongly developed. I project on the screen the magnified image of a horizontal section of the bark of the cork oak; you see nine or ten bands running parallel to each other: these are the layers of cellulose matter that have been deposited in successive years. I turn the specimen, and you now see the vertical section with the radiating passages clearly marked.

The difference between the arrangement of the cells or tissue forming the woody part of the tree and the bark is easily shown. I have here three metal sockets, supported over a shallow wooden tray. Into them are fitted, first, a cork cut out of the bark in a vertical direction, next, a cork cut in a radial direction, and, lastly, a piece of common yellow pine. By means of my force-pump, I apply a couple of atmospheres of hydraulic pressure. I project an image of the apparatus on the screen, and you see the water has made its way through the wood and through the cork cut in the radial direction, while the cork cut in the vertical direction is impervious.

The cork tree, a species of evergreen oak, is indigenous in Portugal and along both shores of the Mediterranean. The diagram on the wall has been painted from a sketch obligingly sent to me by Mr. C. A. Friend, the resident engineer of the Seville Waterworks, to whom I am also indebted for this branch of a cork tree, these acorns, this axe used in getting the cork, and for a description of the habits of the tree, its cultivation, and the mode of gathering the harvest.

The cork oak attains a height of 30 to 40 feet; it is not cultivated in any way, but grows like trees in a park. The first crop is not gathered till the tree is thirty years old, the next nine or ten years later; both these crops yield inferior cork, but at the third crop, gathered when the tree is fifty years old, the bark has attained full maturity, and after that will yield the highest quality of cork every nine or ten years. In the autumn of the year, when the bark is in a fit state, that is, for small trees, from three-quarters of an inch to one inch thick, and for larger ones up to one inch and a half, a horizontal cut is made, by means of a light axe like the one I hold in my hand, through the bark a few inches above the ground; succeeding cuts are made at distances of about a yard, up to the branches, and even along some of the large ones, then two or more vertical cuts, according to the size of the tree; and the bark is ripped off by inserting the wedge-shaped end of the axe-handle. In making the cuts great care is taken to avoid wounding the inner bark, upon the integrity of which the health of the tree depends; but where this precaution is taken, the gathering of the cork does not in any way injure the tree.

After stripping, the cork is immersed for about an hour in hot water, it is dressed with a kind of spokeshave, then laid out flat and weighted in order to take out the curvature; it is then stacked in the open air, without protection of any kind, for cork does not appear to be susceptible of receiving injury from the weather.

The minute structure of the bark is very remarkable. First, I project on the screen a microscopic section of the wood of the cork tree. It is taken in a horizontal plane, and I ask you to notice the diversity of the structure, and especially the presence of large tubes or pipes. I next exhibit a section taken in the same plane of the corky portion of the bark. You see the whole substance is made up of minute many-sided cells about 1/750 of an inch in diameter, and about twice as long, the long way of the cells being disposed radially to the trunk. The walls of the cells are extremely thin, and yet they are wonderfully impervious to liquids. Looked at by reflected light, if the specimen be turned, bands of silvery light alternate with bands of comparative darkness, showing that the cells are built on end to end in regular order. The vertical section next exhibited shows a cross section of the cells looking like a minute honeycomb. In some specimens large numbers of crystals are found. These could not be distinguished from the detached elementary spindle-shaped cells, of which woody fibre is made up, were it not for the powerful means of analysis we have in polarised light. I need hardly explain to an audience in this Institution that light passed through a Nicol prism becomes polarised, that is to say, the vibrations of the luminiferous ether are all reduced to vibrations in one plane, and, consequently, if a second prism be interposed and placed at right angles to the first, the light will be unable to get through; but if we introduce between the crossed Nicols a substance capable of turning the plane of vibration again, then a certain portion of the light will pass. I have now projected on the screen the feeble light emerging from the crossed Nicols. I introduce the microscopic preparation of cork cells between them, and you see the crystals glowing with many-coloured lights on a dark ground.

Minute though these crystals are, they are very numerous and hard, and it is partly to them that is due the extraordinary rapidity with which cork blunts the cutting instruments used in shaping it. Cork-cutters always have beside them a sharpening-stone, on which they are obliged to restore the edges of their knives after a very few cuts.

The cells of the cork are filled with gaseous matter, which is very easily extracted, and which has been analysed for me by Mr. G. H. Ogston, and proved to be common air. I have here a glass tube in which are some pieces of cork which have been cut into slices so as to facilitate the escape of the air. I connect the tube with an exhausted receiver and project the image on the screen; you see rising from the cork bubbles of air as numerous, but much more minute than the bubbles which rise from sparkling wines; much more minute, because the bubbles you see are expanded to seven or eight times their volume at atmospheric pressure on account of the vacuum existing in the tube. The air will continue to come off for an hour or more, and from measurements made by Mr. Ogston I find that the air occluded in the cork amounts to about 53 per cent. of its volume. The facility with which the air escapes, compared with the impermeability of cork to liquids is very remarkable.

I throw on the screen the image of a section cut from a cork which was kept under a vacuum of about 26 inches for five days and nights; aniline dye was then injected, and yet you see that the colour has not more than permeated the outermost fringe of cells—those, in fact, which had been broken open by the operation of cutting the cork. By keeping cork for a very long time in an almost perfect vacuum, and then injecting dye, a slight darkening of the general colour of a section of the cork may be noticed, but it is very slight indeed. How, then, does the air escape so readily when the cork is placed *in vacuo?*

The answer is, that gases possess the property of diffusion; that is, of passing through porous media of inconceivable fineness. When two gases, such as hydrogen and air, are separated by a porous medium, they immediately begin to pass into each other, and the lighter gas passes through more quickly than the heavier.

I have here a glass tube, the upper end of which is closed by a thin slice of cork, the lower end dips into a basin of water. Some hours ago the tube was filled with hydrogen, which you know is about 14½ times lighter than air; consequently, according to the law of diffusion, it will get out of the tube through the cork quicker than the air can get in by the same means, and the result must be that a partial vacuum will be formed in the tube, and a column of water will be drawn up. You see that such has been the case, and we have thus proved that the cells of cork are eminently pervious to gases. The pores in the cell-walls appear, however, to be too minute to permit the passage of liquids.

I closed the end of a glass tube 11 mm. diameter, with a disk of cork 1·75 mm. thick, cut at right angles to the axis of the tree; I placed a solution of blue litmus inside the tube, and suspended it in a weak solution of sulphuric acid. Had diffusion taken place, both liquids would have assumed a red colour, but after sixteen hours no change whatever could be detected. A like inertness was exhibited when the tube was filled with a solution of copper sulphate and suspended in a weak solution of ammonia; a deep blue colour would have appeared had any intermixture taken place, and the same tube is before you immersed in ammonia and filled with red litmus solution. It has been in this condition since February 28, but no diffusion has taken place. A disk of wood 6 mm. thick under the same circumstances showed, after a couple of hours, by the liquids turning blue, that diffusion was going on actively. It is this property of allowing gases to permeate while completely barring liquids that enables cork to be kept in compression under water or in contact with various liquids without the air-cells becoming water-logged, and that makes cork so admirable an article for waterproof wear, such as boot-soles and hats, for, unlike india-rubber, it allows ventilation to go on while it keeps out the wet. The cell-walls are so strong, notwithstanding their extreme thinness, that they appear, when empty, to be able to resist the atmospheric pressure, for the volume of the cork does not sensibly diminish, even when all the air has been extracted. Viewed under very high power, cross-stays or struts of fibrous matter may be distinguished traversing the cells: these, no doubt, add to the strength and resistance of the structure.

From what you have seen you will have no difficulty in arriving at the conclusion that cork consists, practically, of an aggregation of minute air-vessels, having very thin, very watertight, and very strong walls, and hence, if compressed, we may expect the resistance to compression to rise in a manner more like the resistance of gases than the resistance of an elastic solid such as a spring. In a spring the pressure increases in proportion to the distance to which the spring is compressed, but with gases the pressure increases in a much more rapid manner; that is, inversely as the volume which the gas is made to occupy. But from the permeability of cork to air, it is evident that, if subjected to pressure in one direction only, it will gradually part with its occluded air by effusion, that is by its passage through the porous walls of the cells in which it is contained. This fact can be readily demonstrated by the lever press which I have used, for, if the brass cylinder containing the cork be filled with soap and water and pressure be then applied, minute bubbles will be found to collect on the surface, and their formation will go on for many hours.

On the other hand, if cork be subjected to pressure from all sides, such as operates when it is immersed in water under pressure, then the cells are supported in all directions, the air in them is reduced in volume, and there is no tendency to escape in one direction more than another. An india-rubber bag, such as this, distended by air, bursts, as you see, if pressed between two surfaces, but if an india-rubber cell be placed in a glass tube and subjected to hydraulic pressure, it is merely shrivelled up; the strain on its walls is actually reduced.

To take advantage of the peculiar properties of cork in mechanical applications, it is necessary to determine accurately the law of its resistance to compression, and for this purpose I instituted a series of experiments of this kind. Into a strong iron vessel of 5½ gallons capacity I introduced a quantity of cork, and filled the interstices full of water, carefully getting out all the air. I then proceeded to pump in water, until definite pressures up to 1000 pounds per square inch had been reached, and, at every 100 pounds, the weight of water pumped in was determined. In this way, after many repetitions, I obtained the decrease of volume due to any given increase of pressure. The observations have been plotted into the form of a curve, which you see on the diagram on the wall. The base-line represents a cylinder containing one cubic foot of cork divided by the vertical lines into ten parts; the black horizontal lines according to the scale on the left hand represent the pressures in pounds per square inch which were necessary to compress the cork to the corresponding volume. Thus to reduce the volume to one-half, required a pressure of 250 pounds per square inch. At 1000 pounds per square inch the volume was reduced to 44 per cent.; the yielding then became very little, showing that the solid parts of the cells had nearly come together, and this corroborates Mr. Ogston's determination that the gaseous part of cork constitutes 53 per cent. of its bulk. The engineer, in dealing with a compressible substance, requires to know not only the pressure which a given

change of volume produces, but also the work which has to be expended in producing the change of volume. The work is calculated by multiplying the decrease of volume by the mean pressure per unit of area which produced it. The ordinates of the dotted curve on the diagram with the corresponding scale of foot-pounds on the right-hand side are drawn equal to the work done in compressing a cubic foot of cork to the several volumes marked on the base-line. I have not been able to find an equation to the pressure curve; it seems to be quite irregular, and hence the only way of calculating the effects of any given change of volume is to measure the ordinates of the curve constructed by actual experiment. As may be supposed the pressures indicated by experiment are not nearly so regular and steady as corresponding experiments on a gas would be, and the actual form of the curves will depend on the quality of the cork experimented on.

The last point of importance in this inquiry relates to the permanence of elasticity in cork.

So far as preservation of elasticity during years of compression is concerned, we have the evidence of wine corks to show that a considerable range of elasticity is retained for a very long time. With respect to cork subjected to repeated compression and extension, I have very little evidence to offer beyond this, that cork which had been compressed and released in water many thousand times had not changed its molecular structure in the least, and had continued perfectly serviceable. Cork which has been kept under a pressure of three atmospheres for many weeks appears to have shrunk to from 80 to 85 per cent. of its original volume.

I will conclude this lecture by bringing under your notice two novel applications of cork to the arts.

Before the lecture-table stands a water-raising apparatus called a hydraulic ram. The structure of the machine is shown by a diagram on the wall. The ram consists of an inclined pipe, which leads the water from a reservoir into a chamber which terminates in a valve opening inwards. Branching up from the chamber is a passage leading to a valve, opening outwards and communicating with a regulating vessel, which is usually filled with air, but which I prefer to fill with cork and water. Immediately beyond the inner valve is inserted a delivery pipe, which is laid to the spot to which the water has to be pumped, in this case to the fountain jet in the middle of this pan.

The action of the ram is as follows:—The outer valve, which opens inwards, is, in the first instance, held open, and a flow of water is allowed to take place through it down the pipe and chamber. The valve is then released, and is instantly shut by the current of water which is thus suddenly stopped, and, in consequence, delivers a blow similar to that produced by the fall of a hammer on an anvil, and just as the hammer jumps back from the anvil, so does the water recoil back to a small extent along the pipe.

During this action, first, a certain portion of water is forced by virtue of the blow through the inner valve, opening outwards, into the cork vessel, and so to the delivery pipe, and instantly afterwards the recoil causes a partial vacuum to form in the body of the ram, and permits the atmospheric pressure to open the outer valve and re-establish a rush of water as soon as the recoil has expended itself. In the little ram before you, this action, which it has taken so long to describe, is repeated 140 times in a minute.

The ram is now working. You hear the regular pulses of the valve, and you see a jet of water rising some 10 feet into the air. I throw the electric light on the water, and I ask you to notice the regularity of the flow. You can, indeed, detect the pulses of the ram in the fountain, but that is because I am only using a regulating vessel of the same capacity as that generally used for air, and you will recollect that 44 per cent. of the substance of cork is solid and inelastic. By closing a cock I can cut off the cork vessel from the ram; you see the regularity of the jet has disappeared, it now goes in leaps and bounds. This demonstrates that the elasticity of cork is competent to regulate the flow of water. When air is used for this purpose the air-vessel has to be filled, and, with most kinds of water, the supply has to be kept up while the ram is working, because water under pressure absorbs air. For this purpose a "sniff-valve" is a necessary part of all rams. It is a minute valve opening inwards, placed just below the inner valve; at each recoil a small bubble of air is drawn in and passed into the air-vessel. This "sniff-valve" is a fruitful source of trouble. Its minuteness renders it liable to get stopped up by dirt; it must not, of course, be submerged, and, if too large, it seriously affects the duty performed by the ram. The use of cork gets rid of all these difficulties, no sniff-valve is needed, the ram will work deeply submerged, and there is no fear of the cork vessel ever getting empty. The duty which even the little ram before you has done is 65 per cent., and larger ones have reached 80 per cent.

The second novel application of cork is for the purpose of storing a portion of the energy of the recoil of cannon, for the purpose of expending it afterwards in running them out.

The result of the explosion of gunpowder in a gun is to drive the shot out in one direction, and to cause the gun to recoil with equal energy the opposite way. To restrain the motion of the gun "compressors" of various kinds are used, and in this country, for modern guns, they are generally hydraulic, that is to say, the force of recoil is expended in causing the gun to mount an inclined plane, and, at the same time, in driving a piston into a cylinder full of water, the latter being allowed to squeeze past the piston through apertures, the areas of which are either fixed or capable of being automatically varied as the gun recedes; or else the water is driven out of the cylinder through loaded valves. As a rule, the gun is moved out again into its firing position by its weight causing it to run down the inclined plane, up which it had previously recoiled. For naval purposes, however, this plan is inconvenient, because the gun will not run out to windward if the vessel is heeling over, on account of the inclined plane becoming more horizontal, or even inclined in the reverse direction, and should the ship take a permanent list, from a compartment getting full of water, the inconvenience might be very considerable.

In land service guns, when mounted in barbette, the rising of the gun exposes it and the loading detachment more to the enemy's fire, and in both cases, when placed in ports or embrasures, the ports must be higher than if the gun recoiled horizontally, and will therefore offer a better mark to the enemy's fire, especially that of machine guns, while the sudden rise of the gun in recoiling imposes a severe downward pressure on the deck or on the platform.

To obviate these disadvantages I have contrived the gun-carriage a model of which is before you on the table, and a diagram of which on the wall illustrates the internal construction. The gun is mounted on a carriage composed of two hydraulic cylinders, united so as to form one piece. The carriage slides on a pair of hollow ways, and also on to a pair of fixed rams, the rear ends of which are attached to the piece forming the rear of the mounting. There are water passages down the axes of the rams, and these communicate through an automatic recoil-valve, opening from the cylinders, with the two hollow slides. There is a second communication between the cylinders and slides by means of a cock, which can be opened or shut at pleasure. The hollow slides are packed full of cork and water, the latter also completely filling the cylinders, rams, and various connecting passages.

By means of a small force-pump enough water can be injected to give the cork so much initial compression as will suffice to run the gun out when the slides are inclined under any angle which may be found convenient.

When the gun is fired, the cylinders are driven on to the rams, and the water in the cylinders is forced through the hollow rams into the cork and water vessels formed by the slides, and the cork is compressed still farther. When the recoil is over, the automatic recoil-valve closes, and the gun remains in its rearward position ready for loading.

As soon as loaded, the running-out cock is opened, the expansion of the cork drives the water from around it into the cylinders, and so forces the gun out.

If it be desired to let the gun run out automatically immediately after recoil, it is only necessary to leave the running-out cock open, and then the water forced among the cork by recoil returns instantly to the cylinders, and runs the gun out quicker than the eye can follow the motion.

I will now load the model and fire a shot into this strong steel cylinder, at the bottom of which is a thick layer of soft wood. I will close the running-out valve, so that the gun shall remain in the recoiled position. Sir Frederick Abel has kindly arranged some of his electric fuses specially to fit this minute ordnance, and I can fire the gun by means of a small electro-magnetic battery. The gun has now recoiled, and remains in its rear position. I load again, open the running-out cock, the gun runs out, and I fire without closing the cock. You see the gun has recoiled and run out instantly again.

The arrangement I have adopted may be made by using air

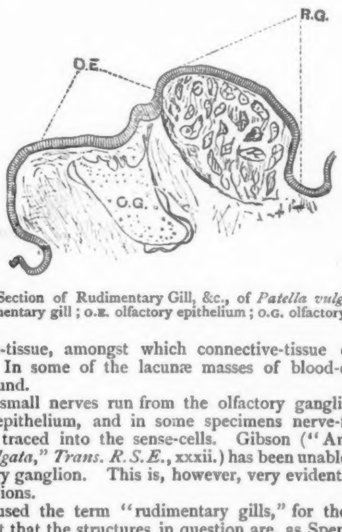
instead of cork, but air is a troublesome substance to deal with; it leaks out very easily, and without showing any signs of having done so, which might readily lead to serious consequences. A special pump is required to make up loss by leakage.

The merit of cork is its extreme simplicity and trustworthiness. By mixing a certain proportion of glycerine with the water it will not freeze in any ordinary cold weather.

NOTE ON THE RUDIMENTARY GILLS, ETC., OF THE COMMON LIMPET (PATELLA VULGATA)

SPENGEL, in his admirable paper "Die Geruchsorgane und das Nervensystem der Mollusken" (*Zeitschrift f. wiss. Zool.* xxxv.), figures a transverse section of one of the rudimentary gills and its surroundings. This appears to be incorrect in one or two particulars. In the first place the gill is figured as projecting freely at the surface. The examination of numerous sections has, however, convinced me that the epithelium is continued over the gill, being very high where continuous with the olfactory epithelium over the ganglion, but gradually getting lower, and passing into the ordinary epithelium, which lines the nuchal chamber. Consequently the rudimentary gill is *beneath* the surface, and moreover the sensory tract is partly extended over it, not being confined to the region immediately superjacent to the olfactory ganglion. Cunningham (*Q.J.M.S.*, xxii.), calls attention to the true relations of the gill, but gives no figure.

Spengel also represents the rudimentary gill as being full of large blood-sinuses, but carefully-prepared specimens show that these are in reality traversed by numerous fine strands of connective-tissue. The entire organ is made up of trabeculæ of



Transverse Section of Rudimentary Gill, &c., of *Patella vulgata* (× 90). R.G. Rudimentary gill; O.E. olfactory epithelium; O.G. olfactory ganglion.

connective-tissue, amongst which connective-tissue corpuscles abound. In some of the lacunæ masses of blood-corpuscles may be found.

Several small nerves run from the olfactory ganglion to the olfactory epithelium, and in some specimens nerve-fibres can almost be traced into the sense-cells. Gibson ("Anatomy of *Patella vulgata*," *Trans. R.S.E.*, xxxii.) has been unable to detect an olfactory ganglion. This is, however, very evident in microscopic sections.

I have used the term "rudimentary gills," for there seems little doubt that the structures in question are, as Spengel advocates, of this nature, but, lying as they do beneath the surface, they can hardly be functional. This position, too, suggests that these organs must have been rudimentary for a very long time. As Patella (Palacmæa) occurs in the fossil state as far back as the Middle Cambrian (Sedg.), the pallial gills may have been developed for a considerable period.

If, as Spengel believes, the molluscan olfactory organ enables the animals of that group to perceive the quality of the water passing over the gills, it is difficult to understand its well-developed state in Patella, where its position would appear to prevent such a use. Hence the olfactory organ in this form probably has some other function—possibly it may have something to do with the locality-sense, though this is very improbable (see note by author on "The Habits of the Limpet," NATURE, vol. xxxi. p. 200). The preceding observations were made at the Scottish Marine Station.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—At the annual Scholarship election at St. John's College the following awards were made to students of Mathematics and Natural Science:—Hutchinson Studentship of 60*l*. a year for two years to A. C. Seward (First Class Nat. Sciences Tripos, Part II.), to enable him to follow up his researches in Fossil Botany; Hockin Prize for Physics with especial reference to Electricity, to Stroud (First Class Nat. Sciences Tripos, Part II.); Herschel Prize for Astronomy to Fletcher (Second Wrangler); Hughes Prizes for Mathematics to Fletcher, and for Natural Science to Rolleston (First Class Nat. Sciences Tripos, Part II.); Wright's Prizes for Mathematics to Baker and Orr, for Natural Science to Lake and Groom; Foundation Scholarships in Mathematics to Middlemast, Pressland, Tate, Bradford, Flux, and in Natural Science to Lake and W. Harris; extension of tenure of Scholarships to Kirby, Mossop, Bushe-Fox, and Baker in Mathematics, and to Shore and Turpin in Natural Science; Exhibitions in Mathematics to Hill, Fletcher, A. E. Foster, Norris, Varley, H. H. Harris, Orr, Greenidge, Flux, Card, Palmer, Millard, and in Natural Science to Lake, Groom, Rolleston, Seward, W. Harris; a Proper Sizarship in Natural Science to Cowell.

The following gentlemen have obtained first-class honours in the Natural Sciences Tripos, Part II., the subject for which they were specially classed being given after the name:—Carnegie, Chemistry, Caius; Edkins, Physiology, Caius; Hawkridge, Geology, Clare; Hudson, Physics, Pembroke; F. W. Oliver, Botany, Trinity; Rolleston, Human Anatomy with Physiology, St. John's; Seward, Geology, St. John's; Skinner, Chemistry, Christ's; Stroud, Physics, St. John's. Miss Freund, of Girton, was placed in the first class for Chemistry.

Messrs. Dixon, of Trinity College, and Fletcher, of St. John's, are respectively Senior and Second Wranglers. Both were educated at New Kingswood School, Bath, under Mr. T. G. Osborn. Miss Frost, of Newnham College, was placed between the 24th and 25th Wranglers.

In a recent discussion Prof. Stuart stated that 58 students attended the engineering courses and workshops in the Lent Term. Of these 32 were to be engineers; 7 were to engage in manufactures in which a knowledge of engineering was desirable; 3 were going into the army; 2 were to become teachers. As to their University position, 9 were M.A. or B.A., 21 were ready for the Mathematical Tripos, 2 for the Natural Sciences Tripos, 18 for the Special Examinations in Applied Science; 6 had only come to the University for a year's work in the workshops; 5 were not matriculated students.

DR. ORME MASSON, a graduate of Edinburgh University, and lately Elective Fellow in Chemistry, has been appointed to the Chair of Chemistry at Melbourne, Australia.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tome ix., fasc. 1, 1886.—The present number gives the usual annual recapitulation of the rules of the Society, the lists of members, addresses by the outgoing and incoming presidents, financial and other reports, &c.—M. Moncelon laid before the Society a *résumé* of the principal results of his observations on the half-castes of New Caledonia during his residence in the colony. He drew attention to the evils resulting from the practice commonly followed by the native mothers of half-castes, of going back with their children to their native tribes, amongst whom these half-whites grow up in slavery as savages.—On certain Hova and Sakalava skulls, by M. Trucy. Both of these cranial groups are dolichocephalic, with an index of about 74, which is nearly the same as that of the Arabs of Algiers and the pariahs of Bengal. The Hovas and Sakalavas appear to be more intelligent than any other tribes of Madagascar, but while the Sakalava queen, the ally of France, submitted with her husband to be made the subject of careful anthropometrical observations, she enjoined upon the French officers to punish with death any one who opened or rifled a grave. It was consequently only by artifice and extreme circumspection that M. Trucy was able to obtain crania or other human bones. In the discussion which followed, regarding the mixed characters of the Hova crania, MM. Topinard, Dally, and others entered warmly into the question of typical and other distinctions of race.—On the development, in the adult, of supernumerary digits, by M. Fauvelle.

This paper, which supplies some suggestive and not uninteresting matter, is based upon observations on the abnormal development in a full-grown axolotl of a fifth digit at the base of the fourth, and the gradual reparation, by multiplication of the parts, of various injuries to the other phalanges. Dr. Fauvelle considers at length the conditions on which the formation of supplementary parts in the adult may possibly depend, and whether we may not refer such abnormal manifestations of activity to a reversion in the cells of the connective-tissues to an embryonic condition, in which segmentation is possible. M. Avia, in confirming the views of Dr. Fauvelle as to the influence of heredity in the human species on the appearance of supernumerary organs, instanced the family of the Fodli, which for several centuries had exercised patriarchal supremacy over a tribe of the Arab Hyamites. In this family, whose members are not allowed to marry beyond the limits of their own kindred, polydactylism has become an established hereditary character, and is considered as an indispensable evidence of legitimacy, and right of succession. M. Avia has personally examined various Fodli, all of whom had twenty-four phalanges on their hands and feet.—On heredity, by Dr. Fauvelle. In this, as in the preceding paper, the author draws attention to the injury done to scientific inquiry by the constantly increasing recklessness with which physiological and anatomical conditions, whose causes we are ignorant of, are indiscriminately referred to so-called "atavism." It must be confessed, however, that the author himself in his exposition of the significance of the phenomena of heredity, as given in this paper, and in his more recent communication to the Society of his views regarding the real or assumed existence of atavism, exhibits the same want of accuracy and close definition which he condemns in others, and the vagueness of the opinions which he has enunciated with such dogmatic temerity excited a lively controversy, in which MM. Laborde and Sanson, and Mme. Cl. Royer, with other members, took part. —On primitive forms of numerations, by M. Letourneau. In this paper, and in the discussion which followed its reading, attention was drawn to the development, among some peoples, of a decimal system of numeration from the natural counting of the fingers, while according to Bachofen and others, the decimal method was preceded, in those earlier periods of civilisation in which the matriarchal principle was still in force, by the *octomal* system. Curious evidence of the prevalence of this practice of counting by 8 is afforded in Sanskrit, and in Greek and Latin, as well as in several modern European forms of speech, by the close affinity, if not identity, of the words signifying nine and new, as, *e.g.*, the French "neuf," thus showing that the numeral following eight was of more recent acceptation than the final term of the octomal form of numeration.

Bulletin de l'Académie des Sciences de St. Pétersbourg, vol. xxi. No. 1.—List of the members of the Academy on March 1, 1886. —Diagnoses of new plants from Asia, by C. J. Maximowicz, part 6 (Latin), containing a good many new species.—Report on new linguistic materials contained in the "Codex Comanicus," by Prof. Radloff (German).

SOCIETIES AND ACADEMIES

London

Royal Society, June 10.—"A Minute Analysis (experimental) of the various Movements produced by stimulating in the Monkey different Regions of the Cortical Centre for the Upper Limb, as defined by Prof. Ferrier." By Charles E. Beevor, M.D., M.R.C.P., and Prof. Victor Horsley, F.R.S., B.S., F.R.C.S.

The following investigation was undertaken as prefatory to a research into motor localisation of the spinal cord.

Anatomy.—(1) Attention is drawn to some minute details of the topographical anatomy of the upper limb centres as defined by Prof. Ferrier.

(2) Outlines of the shape and arrangement of the fissure of Rolando, the præcentral and intra-parietal sulci.

(3) Proof adduced in support of the authors' opinion that the small horizontal sulcus named X by Prof. Schäfer really corresponds to the superior frontal sulcus of man.

Previous Researches.—Ferrier's results are then given in full.

Method of Experimentation is explained in detail, as also the mode of subdivision of the part of the cortex investigated into centres of about 2 mm. square.

From the results of excitation are then deduced the two following axioms:—

Axiom I.—Viewing as a whole the motor area of the central cortex for the upper limb, as defined by Prof. Ferrier, we find that the regions for the action of the larger joints are situated at the upper part of the area, *i.e.* closer to the middle line, while those for the smaller and more differentiated movements lie peripherally at the lower part of the area.

Axiom II.—As a broad result, extension of the joints is the most characteristic movement of the upper part of Ferrier's arm centre; while flexion is equally characteristic of the movements obtained by stimulating the lower part. Finally, between these two regions there is a small portion where flexion and extension alternately predominate, a condition to which we have given the name of *confusion*. (Here both flexors and extensors are contracting at the same time, and consequently the joint is usually fixed in a neutral position, each group of muscles alternately drawing it in opposite directions.)

Priority of Movements is found to take place, and follows the "march" first indicated by Dr. Hughlings Jackson as existing in epileptic seizures.

This *march* is in accordance with Axiom I., since the shoulder commences the series of movements in the uppermost part of the area, the thumb at the lowest part, and the wrist in the intermediate part.

Summary.—(1) That X is the superior frontal sulcus of man.

(2) That the movements of the joints are progressively represented in the cortex from above down.

(3) Localisation of sequence of movements.

(4) Localisation of quality of movements.

(5) That there is no absolute line of demarcation between the different centres.

Mathematical Society, June 10.—J. W. L. Glaisher, F.R.S., President, in the chair.—At a special meeting the following resolution was unanimously carried:—"That the Council be empowered to take the necessary steps to obtain a charter of incorporation for the Society."—At the ordinary meeting Messrs. A. R. Forsyth, F.R.S., R. Lachlan, and the Rev. J. J. Milne were admitted into the Society.—The following communications were made:—Reciprocation in statics, by Prof. Genese.—On the theory of screws in elliptic space (third note), by A. Buchheim.—Some applications of Weierstrass's elliptic functions, by Prof. Greenhill.—Formula for the interchange of the independent and dependent variables with some applications to reciprocants, by C. Leudesdorf (second paper on reciprocants), by L. J. Rogers.—On the motion of a liquid ellipsoid under the influence of its own attraction, by A. B. Basset.—Electrical oscillations on cylindrical conductors, by Prof. J. J. Thomson, F.R.S.

Chemical Society, May 20.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—Sources of error in the calorimetric study of salts, by Prof. W. A. Tilden, F.R.S.—On the action of aldehydes and ammonia on benzil, by Francis R. Japp, F.R.S., and W. Palmer Wynne, B.Sc.—On imabenzil, by the same.—On ammonia-derivatives of benzoïn, by Francis R. Japp, F.R.S., and W. H. Wilson, Ph.D.—On compounds from benzil and benzoïn and alcohols, by Francis R. Japp, F.R.S., and Julius Raschen.—On the action of phosphoric sulphide on benzophenone, by the same.—The separation and estimation of zirconium by means of hydrogen peroxide, by G. H. Bailey, D.Sc., Ph.D.—An apparatus for the determination of the temperature of decomposition of salts, by the same.—The retention of lead salts by filter-paper, by L. Trant O'Shea.

June 3.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—Notes on Sir W. Fairbairn's experiments on re-melting cast iron, by Thomas Turner, Assoc. R.S.M.—Some ammonium compounds and other derivatives of α-1' hydroxyquinoline, by C. A. Kohn, B.Sc., Ph.D.—β-sulphophthalic acid, by Prof C. Graebe and A. Rée, Ph.D.—Compounds obtained by the aid of β-sulphophthalic acid, by the same.—Derivatives of taurine (part 2), by J. William James.

Anthropological Institute, June 8.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Mr. Joseph J. Mooney was announced.—Mr. C. H. Read read a paper on the ethnological exhibits in the Colonial and Indian Exhibition, in which he reviewed briefly the collections to be seen in the various courts, and described in detail some of the objects. The author dwelt especially upon the meagreness of the collection sent from the Dominion of Canada, where there is such a vast

field for ethnological inquiry.—Miss Buckland read a paper on American shell-work and its affinities, in which it was pointed out that the resemblance in shell ornaments found in mounds in various States of North America to those existing in the Solodmon and Admiralty Islands renders it highly probable that a commerce was carried on between the islands of the Pacific anthe American continent prior to the Spanish conquest.—A paper by Mr. C. W. Rosset, on the Maldive Islands, was read. The group contains upwards of 12,000 islands, which lie in clusters called atolls, of which there are more than twenty. The king's or sultan's island is situated in Malé Atoll, and here Mr. Rosset spent seventy days, as the sultan would not allow him to visit the other atolls. The natives live almost entirely upon fish and rice; and as the islands are not capable of producing grain of any kind, the rice has to be imported from India, the nearest point of which is about 350 miles distant. The author gave an interesting description of the customs of the natives, and exhibited a large collection of photographs, dresses, and other objects of ethnological interest.

Royal Meteorological Society, June 16.—Mr. W. Ellis, F.R.A.S., President, in the chair.—The Rev. J. R. Boyle and Mr. H. B. de la Poer Wall, M.A., were elected Fellows of the Society.—The following papers were read:—Note on a sudden squall, January 13, 1886, by Mr. R. H. Scott, F.R.S. This is an account of a remarkably sudden squall of about ten minutes' duration, which passed over the south of England on the morning of January 13. It was first recorded at Falmouth at 8.20 a.m., and passed over London at 10.40 a.m.—The floods of May 1886, by Mr. F. Gaster, F.R.Met.Soc., and Mr. W. Marriott, F.R.Met.Soc. The month of May 1886 will long be remembered for the heavy rains that occurred between the 11th and 13th, and the floods they produced over the greater part of the west and midland counties of England. In fact, at Worcester the flood was higher than any that have occurred there since 1770. On the 11th and 12th heavy rain fell over the east of England, there being over 3 inches during these two days at several places in counties Down, Dublin, and Wexford; the greatest reported being 3·52 inches at Kilkeel, co. Down. Over the other parts of the United Kingdom the rainfall on the 11th was under 1 inch. Rain, however, commenced falling about noon on Tuesday over the midland counties, and continued with increasing intensity till Friday morning; the duration at most places being about sixty hours. The heaviest rainfall occurred in Shropshire, where over 6 inches fell at several stations; while at Burwarton as much as 7·09 inches was recorded, the amounts for each day being 0·60 inches on the 11th, 3·10 inches on the 12th, and 3·39 inches on the 13th Very serious floods followed these heavy rains. At Shrewsbury the extreme height of the flood on the Severn was 16 feet, and at Worcester 17 feet 1 inch, above the average summer level. At Ross the flood on the Wye was 14 feet; at Nottingham the rise of the water in the Trent was 12½ feet; at Rotherham the flood was 8 feet 5 inches; and in North-East Yorkshire the Derwent rose to nearly 11 feet above summer level. These floods caused great damage to property and loss of life; bridges were washed away; railway traffic suspended; and thousands of workmen thrown idle. In several places the waterworks were flooded, and the towns' water-supply was consequently cut off. Mr. Gaster drew attention to the complex character of pressure-distribution during the time referred to, and showed how the region of maximum rainfall followed certain of the shallow depressions which appeared over the British Islands. He drew attention to the peculiarities of this type of depression, showing how in many, if not in most, cases the rainfall was heaviest in their rear, and was brought by the easterly, not by the westerly, wind. He also referred to some previous instances of heavy floods, in which similar atmospheric conditions prevailed, and explained how it was that, as the disturbance passed off, snow fell instead of rain, this in its turn being followed by severe cold and in some places frost.—On atmospheric pressure and its effect on the tidal wave, by Capt. W. N. Greenwood, F.R.Met.Soc. The object of this paper is to show how a little knowledge of weather-forecasting, with some practical knowledge of local weather changes and a good barometer, will go far towards forming a right correction for application to the predicted height of the tide, and also to determine what that correction should be in its relation to the fluctuations of the barometer and the prevailing gradient.—Meteorological results at Levuka and Suva, 1875-85, with notes on the climate of Fiji, by Mr. J. D. W. Vaughan, F.R.Met.Soc. The climate of Fiji is remarkably healthy. Diseases such as fevers of an aggravated and malarious character, cholera, and liver complaints are unknown.

EDINBURGH

Royal Society, June 7.—The Hon. Lord Maclaren, Vice-President, in the chair.—Dr. H. R. Mill and Mr. J. T. Morison, of the Scottish Marine Station, read a paper on tidal variations of salinity and temperature in the estuary of the Forth. They divide a river-system into four parts: (1) the *river proper* with its tributaries and feeding-lakes, in the whole of which the water is fresh; (2) the *estuary*, in which the river-water meets that of the firth or sea, and in which there is rapid change of salinity with position and great tidal differences; (3) the *firth* or sea-inlet, in which there is a very uniform and gradual increase of salinity from estuary to sea; (4) the *sea proper* adjacent to the mouth of the firth. It was shown that the temperature of the river in spring and summer being higher than that of the firth, and in consequence surface-water being warmer as well as fresher than bottom-water, the curves representing vertical distribution of salinity and of temperature were identical. Hence the interaction of river and firth waters can be studied as completely by the thermometer as by the hydrometer. In the estuary of the Forth translational motion of the whole mass of water is found to characterise both flood and ebb tide, but about the times of high and low water considerable shearing motion takes place. So long as no shearing occurs, the water is of nearly uniform salinity from surface to bottom at any given time. —Mr. J. J. Barlow communicated a paper on a new method and reagents for detecting chlorides, bromides, and iodides in the presence of each other, and also in the presence of nitrates and chlorates.—Mr. J. A. Thomson gave a paper on the anatomy of *Suberites domuncula*, and also, in conjunction with Mr. P. Geddes, a paper on the history and theory of spermatogenesis.—Dr. J. Waddell gave an account of experiments by which he has determined the atomic weight of tungsten. The methods he used are superior to those previously employed.—Mr. A. H. Auglin discussed certain theorems mainly connected with alternants.

PARIS

Academy of Sciences, June 15.—M. Jurien de la Gravière, President, in the chair.—On the earthquake which occurred in Brazil on May 9, extract from a letter of H.M. dom Pedro d'Alcantara. This disturbance, the first on record, took place in the Petropolis district on May 9 at 3.20 p.m. The vibration, which was of a mild character, lasted scarcely four seconds, and was also felt along the coast as far as Rio de Janeiro, and inland 266 kilometres from that point. It was accompanied by exceptional cold weather, the glass falling to $-5°$ C. in some parts of the province of Minas Geraes, and $-3°$ in other places.—On the absorption spectra of oxygen, by M. J. Janssen. In continuation of his studies on the absorption spectra of the gases, the author deals here with those of oxygen, which reveals some features of great interest for molecular mechanics.—Remarks on the decomposition of the sal ammoniacs by the bases and metallic oxides, by M. Berthelot.—On the ammonia present in the ground (third note), by M. Th. Schlœsing, in reply to MM. Berthelot and André. The question is discussed whether the quantity of ammonia present in vegetable soil is, as a rule, comprised between 0 mg. and 20 mg., as determined by the author, M. Boussingault, and other analysts, or whether this quantity ranges from 78 mg. to 118 mg., as determined by MM. Berthelot and André. It is pointed out that the difference between the two views is a question of quantity; and as the quantity depends on the process of analysis by which it is determined, it ultimately resolves itself into a question of analytical processes.—Lavoisier and the Commission on Weights and Measures, by M. E. Grimaux. Some unpublished documents are printed, showing the action taken by the Commission on behalf of Lavoisier, at that time under arrest as a farmer-general. From one of these documents it appears that, in consequence of said action, the illustrious names of Laplace, Delambre, Borda, and others, were themselves removed from the Commission on the 3rd Nivose of the second year of the Republic (December 26, 1793).—Observations on Fabry's comet, by M. L. Cruls. The spectral analysis made at Rio de Janeiro during the month of May with a spectroscope of slight dispersive power showed distinctly the three bands characteristic of carbon compounds.—Comparative dimensions of the satellites of Jupiter, deduced from observations made during the year 1885, by Dom Lamey.

For the four satellites these observations yielded for the vertical diameters at mean distance the following angular dimensions:—

I.	$1''\cdot176 \pm 0''\cdot360$
II.	$1\cdot281 \pm 0\cdot392$
III.	$1\cdot725 \pm 0\cdot436$
IV.	$1\cdot286 \pm 0\cdot447$

—Note on the herpolhodie (second communication), by M. Hess.—On the measurement of the specific volume of the saturated vapours, and on the value of the mechanical equivalent of heat, by M. A. Perot. Reversing the well-known process of Messrs. Fairbairn and Tait for determining the volume of a known mass of saturated vapour at a given temperature, the author finds the number expressing the mechanical equivalent of heat to be about 424.—Note on a registering hygrometer, by M. Alb. Nodon. This instrument, which is constructed on a principle analogous to that of Breguet's metallic thermometer, is contrived to work for ten consecutive days. Its indications are unaffected by a temperature ranging from .0° to 35° C.—Law determining the electric conductivity of saline solutions of mean concentration, by M. E. Bouty.—Relation between the coefficient of self-induction and the magnetic action of an electro-magnet, by M. Ledeboer.—New magnetic maps of France, by M. Th. Moureaux. The observations, which have served as the groundwork of these charts, were mostly made during the years 1884 and 1885 under the direction of M. Mascart, at seventy-eight stations in every part of France, the results being all referred to January 1, 1885, by comparison with the curves of variation as determined with the magnetograph at the Observatory of the Parc Saint-Maur. From these observations the declination is shown to be least at Belfort (13° 59'·8), greatest at Conquet (19° 25'·1), varying in the north of France about 30' for a degree of longitude, and less in the south.—Summer isobars, winds, and cloudiness on the Atlantic, by M. L. Teisserenc de Bort. The maps embodying these data are based on the records of English and Dutch vessels, comprising 40,900 observations for each element, and on a report on the equatorial region published by the Meteorological Office.—Note on the earthquake in Brazil, by M. Cruls. Although traces of ancient volcanoes and more recent eruptive formations have been detected on the seaboard of Rio de Janeiro, the author considers that this seismic disturbance was not volcanic, but due to shrinking or some analogous movement of frequent occurrence in the crust of the earth. —Reply to some objections made to the memoir on microseismic observations, by M. T. Bertelli.—On the penta-sulphuret of phosphorus, by M. F. Isambert.—On the principle of equivalence in the phenomena of chemical equilibria, by M. H. Le Chatelier. The experimental law serving as the base of pure mechanics—two forces equal to a third are equal to each other, and reciprocally—is true also of chemical equilibria. But in order to eliminate the equivocal notion of *force*, the author substitutes for it another thus formulated: in every phenomenon of equilibrium two material systems equivalent in relation to a third will also remain equivalent in relation to any other system to which they may be opposed, and they are in mutual equilibrium when opposed to each other. This law is here verified in the case of vaporisation, dissociation, solubility, and under other conditions.—On monosodic orthophosphate and arseniate, by MM. A. Joly and H. Dufet.—On a combination of methylic alcohol and anhydrous baryta, by M. de Forcrand.—On the monochloracetate of butyl, by M. G. Gehring. In order to complete the series of monochloracetates, the author has prepared, and determined some of the physical properties of, this substance, adopting the same general method as that employed in the preparation of the monochloracetate of methyl.—On the development of the œsophagus, by M. P. de Meuron.—On the vascular system of *Dorocidaris papillata*, by M. H. Prouho.—On the crystals of gypsum in the pseudo-potters' clays of the Paris district, by M. Stan. Meunier.—Preliminary note on the geological structure of the Lure range, Lower Alps, by M. W. Kilian. This range, which runs for 50 kilometres from the neighbourhood of Vilhosc to Monbrun (Vaucluse), appears to be intermediate between the Alpine and Pyrenean systems. A summary is given of its geological constituents, ranging from the Middle and Upper Jurassic to the Tertiary conglomerates and marls.—On the male fertilisations of Arthropitus and Bornia, by M. Renault.—A contribution to the study of pre-foliation and pre-efflorescence in fossil plants, by M. L. Crié.—Remarks on a meteor observed at the Trocadéro on June 13, by M. L. Jaubert.

STOCKHOLM

Academy of Sciences, June 9.—On the Academy's Zoological Station in the province of Bohus, by Prof. Sven Lovén. —On the resistance of mixtures of acids against electrical conductibility, by Dr. S. Arrhenius.—A collection of ethnographical objects of Central American Indians, presented to the National Museum by the Swedish Consul-General in Guatemala, Mr. S. Ascoli, exhibited and explained by Prof. F. A. Smith. —On the new elementary body germanium, and some of its combinations, by Prof. L. Fr. Nilsson. The researches of Profs. Nilsson and Petterson, made at the request of Prof. Winkler, the discoverer of germanium, show that his suggestion that germanium might possibly be identical with Mendelejeff's ekasilicium is quite correct, and in accordance with the true facts.—Methods for the determination of elements of refraction in prisms having great refracting angles, by Mr. W. Ramsay.—On the mode of occurrence of the sand-worn stones in the Cambrian strata at Lugnås, in Sweden, by Prof. A. G. Nathorst.

BOOKS AND PAMPHLETS RECEIVED

"The First Report upon the Fauna of Liverpool Bay and the Neighbouring Seas," Edited by Prof. Herdman (Longmans).—"L'Inclinaison des Vents" R. P. Marc Dechevrens (Chang Hai).—"Die Alchemie in Alterer und Neuerer Zeit," Erster und Zweiter Theil, by H. Kopp (Winter, Heidelberg).—"An Elementary Treatise on Geometrical Optics," 2nd edition, revised, by W. S. Aldis (Deighton, Bell, and Co.).—"Records of the Saidapet Experimental Farm," by Chas. Benson (Keys, Madras).—"New Commercial Plants and Drugs," No. 9, by T. Christy (Christy).—"Bulletin of the Illinois State Laboratory of Natural History," Vol. II. Art. V. "Studies from the Contagious Diseases of Insects," by S. A Forbes (Franks, Peoria).—"Cornell University: Proceedings in Memory of Louis Agassiz and in Honour of Hiram Sibley, June 17, 1885."

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